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REPORT RESUMES

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TRANSFER THROUGH VERBAL CUEING IN CONCEPT IDENTIFICATION.
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VERBAL CUEING UNDER CONDITIONS COMPARABLE TO THE CLASSROOM WAS STUDIED TO TEST THE HYPOTHESES THAT THE SPECIFICITY OF VERBAL CUES DURING TRAINING IS INVERSELY RELATED TO BREADTH OF TRANSFER OF THE ABILITY TO DISCOVER A PROBLEM SOLUTION IN THE ABSENCE OF CUES. THREE DIFFERENT EXPERIMENTS WERE CARRIED OUT, EACH UTILIZING 50 TO 150 CHILDREN AS SUBJECTS. EACH SUBJECT WAS REQUIRED TO SELECT (IN MULTIPLE-CHOICE FASHION) A PICTURE, FIGURE, OR A WORD WHICH MATCHED A MODEL WITH RESPECT TO A DIMENSION TO BE DISCOVERED. ON CRITERION TESTS, SUBJECTS WERE GIVEN NO CUES. THEY WERE REQUIRED TO FIND, THROUGH THEIR OWN RESOURCES, THE APPROPRIATE BASIS FOR MATCHING. CONCLUSIONS INDICATED THAT--(1) THE CLASS CUE GROUP WAS ABLE TO PERFORM WELL ON THE POST-TESTS, (2) SOME EVIDENCE REGARDING THE MOTIVATIONAL RESULTS OF LEARNING BY DISCOVERY WAS UNCOVERED, (3) THE INVESTIGATOR HAD AN ACUTE PROBLEM IN THAT THE STUDY OF CERTAIN VARIABLES WERE AT THE EXPENSE OF OTHERS, (4) INDICATIONS WERE THAT WHETHER OR NOT DISCOVERY LEARNING IS EFFECTIVE PROBABLY DEPENDS UPON THE LEARNER'S HISTORY OF ASSOCIATIONS TO PROBLEMS AND THE CUES AS WELL AS UPON HIS ACQUIRED METHODS OF DISCOVERING, (5) THE EFFECTIVENESS OF A CUE MAY BE PREDICTED ON THE BASIS OF ITS PREVIOUS ASSOCIATIONS AND ON THE TYPE OF TEST USED TO MEASURE ITS EFFECT, (6) CHILDREN CAN BE TAUGHT TO DISCOVER SOLUTIONS TO CERTAIN TYPES OF PROBLEMS, AND (7) THE PROCEDURE OF DEFINING ABSTRACT CONCEPTS SUCH AS "DISCOVERY" IN OPERATIONAL TERMS OF INDEPENDENT AND DEPENDENT VARIABLES ALLOWS ONE TO ANALYZE THE FUNCTIONAL RELATIONS BETWEEN THEM. (HB)

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TRANSFER THROUGH VERBAL CUEING IN CONCEPT IDENTIFICATION

Cooperative Research Project No. 1684

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University of California, Los Angeles
Los Angeles, California
1964

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PREFACE

The empirical research reported in the following pages is the result of the talent, time, and effort of many people. I especially want to thank the children, who with enthusiasm and interest, participated in the experiment, sometimes daily for several months. I hope that other students will profit from the contribution made by the children of this study. The children's parents, who were interested in advancing knowledge about children's learning, also deserve thanks.

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The final report is presented in 10 chapters and one appendix. The project consisted of three major experiments, each preceded by one or more pilot studies. Chapters I, II, and III present the problem, related research, and the theory and hypotheses. Chapters IV and V present the first experiment and its four pilot studies. The same type of information is present in Chapters VI and VII for the second experiment and in Chapters VIII and IX for the third experiment. Chapter IV also describes the automated equipment.

The major purpose of the pilot studies was exploratory. They were conducted informally to try out materials and training methods for the major experiments. Because these pilot studies were purely developmental, the reader may wish to omit Chapters IV, VI, and VIII and proceed directly to the chapters on the major experiments.

Chapter X presents a summary of the experiment and a discussion of its findings. The Appendix presents the important materials used in one study, the third experiment. Because more than a thousand 35 mm. slides and extensive scripts were prepared, it was not possible to present the materials for all three of the major experiments.

In the original proposal for Project No. 1684 there were two parts or phases. Phase I dealt with abstract materials and Phase II with materials from two areas taught in the schools. In the final report, experiment 1 is the experiment for Phase I of the original proposal, and experiments 2 and 3 represent, respectively, the two areas of Phase II of the original proposal.

The materials used in the three experiments were adapted to study psychological variables. The verbal cues used in the study were ordered in a logical fashion to study the transfer effect of each of them. The cues were not necessarily designed to teach grammar or mathematics per se. The use of the terms grammar and mathematics in this study is meant to denote only some rudiments of these two areas which were designed to be appropriate in difficulty for kindergarten or primary school children. The cues were designed to try to teach children to discover, using rudimentary concepts similar to those which are taught in schools.

It is the author's belief that an important, although tedious, way to obtain knowledge about classroom learning is to analyze complex issues into fundamental components and to study these components in isolation and in interaction with each other. The current state of knowledge about concept identification and about the teaching of problem solving indicates a need for "basic" research which attempts to relate one dimension of stimuli to dependent variables, such as learning, retention, and transfer. This procedure differs from much of educational research, because in the former there is no attempt to study, in toto, global practical issues or to find the one "best" way to teach.

There is need for both types of research. The immediate problems of education require an applied approach which may produce instant results. There is little need to justify that type of research, when the education of millions of children may be improved by its findings.

However, the highly applied research has limited usefulness. It is difficult to generalize its findings or to know which factor or combination of factors are the fundamental and important ones. The justification for studying, as this series of experiments did, only one dimension of a problem is that something definite may then be learned about that one dimension. Hopefully, an analysis of complex problems can produce fundamental information about classroom learning, a type of information which cannot be produced by a more diffuse and practical approach.

M. C. Wittrock
University of California, Los Angeles
March 26, 1964

CHAPTER I. THE PROBLEM

In the research and demonstration activities now current in the field of school learning, the term "discovery" has become a center of discussion. Several mathematics and physical science study groups have developed curricular materials based on what is referred to as a method of "discovery". On the other hand, many advocates of programed instruction have supported a more direct teaching approach through the use of prompting and "rule-and-example" teaching. In the present project, children were taught to "discover" solutions to problems. The children were taught a miniature structure of subject matter which was relevant to the solution of the problems. The various problems selected for each experiment involved the use of at least two to four hypotheses or rules. When he started to solve each problem, the learner did not know the appropriate hypothesis. He was not simply applying a rule to a problem. On the posttests, and without help from anyone, he had to "discover" or to identify the one correct answer.

In this project, carried out with children at the kindergarten-primary level, part of the issue between "discovery" and "direction" was studied. One important aspect of direction, namely, certain types of cueing, was investigated. It was hypothesized that class cues, rather than general cues or specific cues, would produce the greatest transfer to other problems of the same class. It was also hypothesized that for a specific problem-solving task, the specific cue would produce the greatest learning, and for remote transfer the general cue would produce the greatest effect.

There are a variety of ways in which direction might be provided during learning. For example, one might present a sequence of problems so skillfully arranged in difficulty that the step from each problem to the next is small enough to lead the learner unerringly toward the final solution. Or, one might pose a series of challenging problems and offer each learner hints such as visual or verbal cues so that he would be able to apply his own resources to reach a solution.

In the present investigation one aspect of verbal cueing was studied. Attention was focused upon specificity of verbal cues given by a teacher. Other features of teacher assistance were held constant. These other characteristics include number, variety, and order of hints as well as completeness, quality, and frequency of knowledge of results. The major objective of the project was not, therefore, to investigate the best combination of methods of supplying assistance to learners in problem solving. The project studied only one aspect of this broad area, specificity of verbal cues. Each treatment group was provided with only one kind of verbal cue, differing in terms of specificity from the cues given to other treatment groups. It was felt that by concentrating on one element, something definite could be learned about that element. Progress toward the solution of the "learning by discovery" issue may also be made by researching a specific part of the issue. Part of the issue operationally was rephrased as follows: "When children are given verbal cues for a class of solutions, will they show more ability to answer problems of the same class than those children who are given less specific or more specific verbal cues?"

Discovery as an Independent Variable and as a Dependent Variable

Discovery is an unfortunate and sometimes emotionally loaded term. As the term is used in the literature, it suggests that the pupil actively responds to guidance and problems and proceeds to formulate for himself solutions to questions and problems. There has been little rigorous research on the effects of verbal assistance by teachers upon the ability of children to learn, retain, and transfer ability to discover. The recent studies on discovery learning, which are reviewed in Chapter II below, are some of the few attempts to manipulate the effects of verbal cues upon classroom learning. However, these studies have often failed to separate the independent variables, the cues, from the dependent variables of learning, retention, and transfer. For example, the label "discovery" treatment not only describes an environmental event (independent variable) but infers a type of behavior by the learner (dependent variable). The basis for predicting learning and transfer has often been whether or not the student was discovering, rather than the words, sentences, and paragraphs which comprised the cues and which were the actual independent variables. These cues were often lengthy treatments that were difficult to distinguish from each other. In the present study, the ambiguous term "discovery" is a dependent variable. The cue a teacher gives students is the independent variable.

Verbal Cues as the Independent Variables

One of the major problems for the project was to define what is meant by the vague term "discovery". This problem has already been reviewed (Wittrock, 1963; Kersh and Wittrock, 1962). If such a term refers not only to the experimental conditions but to covert behavior by the learner, independent and dependent variables are being confounded. This is especially true if "discovery" is defined in terms of learning or transfer results. It is of no use for a teacher to be told that children who discover learn best when the discovery and the learning are synonymous terms and are both defined by one event, performance on a learning or transfer test. Experimental treatments, as independent variables, must be given definitions which are not contingent upon the dependent variables. It was decided that the independent variable be labeled as types of verbal cues because cueing is descriptive of the treatments and does not imply a causal relationship between the independent variable and the dependent variables. Neither is the definition of the cue contingent upon performance on the dependent variable. Verbal cues are an important independent variable for educational research. They are usually single words. By studying them one at a time, research can examine small bits of communication from a teacher to a student. If the cues relate to a miniature structure of subject matter, they may produce results useful for educational practice.

The verbal cues were ordered in a hierarchy in terms of the number of associations which these cues controlled. Toward one end of this hierarchy would be found highly specific cues which controlled very few responses. At the other extreme, general cues controlled a much broader range of responses.

Between these two extremes of general and specific cues lay many possible cues. The term "class cue" was used in this study to denote one type of cue which occurs between these extremes. A class cue is one which is associated with a concept or a dimension of a stimulus. For example, when the desired response is the selection of the word "book", the spoken word "book" would be a specific cue, the word "noun" would be a class cue, and the term "part of speech" would be a general cue.

Obviously, this classification of cues is defensible only within a study to describe the relative specificity of cues. The terms general, class, and specific denote that the types of cues are ordered on the dimension of specificity. These terms denote nothing more. In this discussion of breadth of class of response, one must recognize that the experimental situation limits the kind and number of responses possible. Under free association conditions, for example, "book" might lead to a greater variety of responses than would "noun" or "part of speech".

Verbal Mediators as the Intervening Variables

To formulate a hypothesis about the relation between specificity of verbal cues and transfer of ability to discover, it was helpful, although not necessary, for the researchers to talk in the language of the mediation hypothesis. By postulating the presence of cue-producing responses in a hierarchical structure it was possible to generate predictions about the transfer effects of certain cues. This project did not test the mediation hypothesis. Other theories or hypotheses might well lead to the same predictions as those below.

The mediation hypothesis (Osgood, 1953, pp. 401-412, 695-699; Dollard and Miller, 1950, pp. 106-109; Mowrer, 1960, pp. 29-162) offers a rigorous, behavioristic approach to the study of complex learning as the product of implicit mediating responses. Because mediation theory emphasizes covert responding rather than simply the direct conditioning of external stimuli to external responses, it provides one appropriate way of describing the effects of verbal cues upon the development of conceptually-mediated behavior, including discovery learning.

Briefly, the mediation hypothesis can be represented as a temporal sequence of stimuli and responses, S-r-s-R, in which an initiating stimulus, *S*, is followed by a mediated response, *r*, and, in turn, by a mediated stimulus, *s*, and a terminating response, *R*. The mediating stimuli and responses are hypothetical, implicit events which are assumed to obey the same principles of learning, including reinforcement, practice, and extinction, as do the observable, initiating stimuli and terminating responses.

Through conditioning, different members of a class of initiating stimuli can evoke a common mediating response (Staats, 1961). The common mediating response represents the common meaning of the stimuli. The stimulation, *s*, produced by the common mediating response can be conditioned to one or more measurable overt responses, *R*.

As types of initiating stimuli, verbal stimuli can be conditioned to mediating responses. The subsequent presentation of these verbal stimuli can evoke part of the meaning of the objects or events which are symbolized and can produce a semantic generalization across stimuli within the class denoted by the verbal label. By adding a verbal stimulus to a class of stimulus objects, the members of the class may become more similar to one another and also less similar to stimuli outside the class. The new similarity within the class generalizes to new members of the class to which the verbal label applies, i.e., a verbal mediated generalization occurs which can be measured on a test of transfer of ability to discover. See Dollard and Miller (1950, pp. 280-304) for a discussion of labels and the teaching of them.

The above approach to verbal stimuli offers one method of talking about certain terms such as strategies, rules, hypotheses, and set often used in research in discovery learning. These labels and sentences denote associations between verbal stimuli and hierarchically arranged mediating responses (Goss, 1961, pp. 264-265). In research on discovery learning, whether the experimenter's presentation of these verbal stimuli facilitates or retards the development of common mediating responses (concepts) is the central question. Also, what effects do the labels for classes of stimuli have upon generalization and discrimination? The mediation hypothesis implies that if verbal stimuli can evoke mediating responses common to a class of stimuli, generalizations should be related to these verbal stimuli. A general cue should produce transfer of ability to discover over a wider range of stimuli than should a specific cue.

Learning, Retention, and Transfer of Ability to Discover as the Dependent Variables

The major argument in favor of "discovery learning" offered by its proponents is that the individual acquires an ability to deal with new problems, a competence which may not be provided by carefully-directed learning.

Furthermore, it is suggested that the learner who has discovered solutions can retain and transfer his ability to discover and can re-establish the learning more readily after some period of time. Operationally defined, learning by discovery should result in retention, remote transfer, or savings in problem solving and concept identification.

In this investigation, the dependent variables involved the discovery of a rule or a concept, which was the basis for matching stimuli. On some of the tests, the rule was one of several to which all subjects had been previously exposed. The task was to select the correct rule. On other tests, subjects had to invent a new rule, one with which they had not been given prior experience.

For this investigation, measures of retention and transfer of ability to "discover" constituted important criteria. In fact, there were, in addition to the test items which were identical to those in the training session, at least one, and usually more, tests of transfer of this ability to discover. These transfer tests are, more precisely, tests of savings, because the transfer is to more difficult problems which require prerequisite training supplied in the experiment. The savings criterion is a most important one in education, and it has been much neglected in recent educational research.

To assess retention in each experiment, tests were given after a three-week interval. The number of criteria used in an experiment varied from four to twelve measures of learning, retention, and transfer.

It should be noted that on the above tests the learner was not simply applying a rule to a problem. He was always required to discover which rule or hypothesis was the correct one. He was never given hints or cues during a test. The tests were designed to sample the learning and the transfer of ability to discover. They were not conventional tests of learning and transfer of a previously learned concept.

Predicting and Controlling the Relationships Between the Independent and Dependent Variables

Experiments which demonstrate the value of discovery learning may yield successful results because children are cued by the teacher to use their own mediators or concepts which have already been well-established during their experiences prior to the experiment. To experiment with the process of optimum teacher cueing of mediating response, it is essential that the prior experiences of the children with the cues be known or controlled. In other words, one must know the associations or the meaning which the children have for the cues which are spoken to them.

In this investigation, the histories of the learners were controlled by teaching a miniature structure of subject matter during periods of preliminary training. After the known hierarchy was developed for each child and for each cue, the act of "discovery" was studied under carefully controlled conditions.

When one knows the prior history of the associations to the cues, it is possible to order them in terms of specificity and to predict their probable effects upon learning and transfer. For example, assume that subjects are taught to associate one beginning term A with a number of B terms. They then associate each B term with a number of C terms and finally each C with a D. One may say that C's are specific cues, while A's are general cues. The B terms occupy an intermediate position. Here the general cue (A) controls several responses (B) each of which in turn might function to produce a specific cue (C). In this respect one can speak of a hierarchy of cues in which the most general are related to a large number of responses through the mediation of cue-producing responses.

On the basis of this discussion it may be seen that terms occupy different positions in the hierarchy. Those terms such as the A term which control indirectly a wide variety of D responses may be expected to act as general cues to produce broad transfer across a wide class of responses. The C terms on the other hand control a single narrow group of responses and may be regarded as specific terms. It is clearly difficult for a specific cue to mediate broad generalization to other classes of cues. The intermediate terms, B, may be thought of as class cues since they control a class of C terms. By relating cues to their position in a hierarchy, mediation theory permits one to offer predictions concerning their relative effectiveness for transfer. General cues, at the top of such a hierarchy, should facilitate broader transfer than specific cues. Behavioristic mediation theory led to the prediction of the above relationship between cueing and ability to discover, and the theory made it apparent that one must know or control the history of association of each child for each cue.

This above use of mediation theory guided the development of materials during the preliminary training as well as the formation of the experimental treatments. In this informal approach there was no implication of any correspondence between the description and the internal processes of the subject. Neither does the project provide a test of mediation theory. These descriptions and predictions presented above may also follow from other theoretical positions. Mediation theory provided a convenient way to talk about the problem and also helped the researchers to generate ideas.

The final part of the problem of control and prediction involved methodology. Only an experimental analysis with school children in an automated classroom setting seemed likely to provide results which would be rigorous and also general to classroom teaching. Apparatus to control the presentation of the stimuli, provide immediate feedback, and automatically record responses was used to collect the data. Abstract stimuli and also meaningful, previously-learned stimuli were separately used with elementary school children in several experiments.

Summary

In summary, the problem was to compare the effectiveness of different verbal cues on the ability of primary school children to discover solutions to types of problems. The first major part of the problem was to control the history of the subjects to the stimuli. The operational definition of terms and relationships among variables in discovery learning was the second major part. Verbal cues by a teacher were the independent variables, and learning, retention, and transfer of ability to discover were the dependent variables.

The third major part of the problem was to predict the relationships among the independent and dependent variables. These predictions were derived from the mediation hypothesis. Fourth, the automated classroom setting was devised to provide rigorous yet useful results for educational thought and practice. Kindergarten and elementary school children were the subjects.

CHAPTER II. RELATED RESEARCH

There are three separate areas of research which are relevant to the study of cueing responses. The first area is the recent research on discovery learning. Wittrock (1963d), Kersh and Wittrock (1962), and Ausubel (1963) provide reviews of these recent studies. Much of the apparent inconsistency of many of these studies has been due to the use of different independent variables and dependent variables. If the studies are considered as they relate to separate dependent variables, much inconsistency in the results disappears. When the dependent variable is learning of a few specific responses, maximum cueing, i.e., giving the student the correct mediator and also the correct specific answer, is the most effective independent variable (Kittell, 1957; Haslerud & Meyers 1958; Wittrock, 1963c). The reason is probably because practice and reinforcement are given for memorizing these associations.

However, when the dependent variables are retention and transfer within a class or transfer within a concept, giving the class cue or mediator for the concept is the most effective type of cueing (Kittell, 1957; Kersh, 1962; Craig, 1956; Katona, 1940; Forgus & Schwartz, 1957; Wittrock, 1963c). Practice and reinforcement for the development of concepts and their application to a variety of problems appears to be the most effective treatment.

When the dependent variable is the generation of new concepts or transfer to new concepts, minimal cueing (Gagnê and Brown, 1961) or what is called general cueing in this study, is the most effective independent variable. Again what is practiced and reinforced as a result of the teacher cue seems to be what is learned.

The second type of research which is relevant to this project is the research on mediated generalization and on semantic generalization. Only the most relevant studies or reviews will be summarized here, since most of the studies in this category are not directly relevant to cueing classroom learning. However, their findings are of great theoretical importance and consistently indicate the transfer value of concepts or mediated responses for a class of stimuli.

In the field of experimental psychology, numerous studies on mediated generalization have indicated the transfer value of mediated responses (Cf. Cofer, 1960; Cofer & Foley, 1942; Goss, 1961). However, these studies were not concerned with the facilitating effect of cueing different types of mediators.

Hull (1920) conducted an extensive series of experiments on various aspects of concept formation including guiding the learner rather than requiring him to discover. One of his major conclusions was, "During the evolution of concepts mildly attracting attention to the common element _in situ_ considerably increases the efficiency of the process."

Kendler & Kendler (1962) indicate that mediated responses help children to transfer within a concept (reversal shift). Jerome Bruner (1961) also studied the effects of mediators upon the learning of children. One group learned the pairs by simple paired-association. In the second group each child was asked to select some word which would help make the association meaningful to him. The third group was required to use as their mediators the words which had been selected by the second group. Since the second group learned and retained more than the third, Bruner concluded that "discovery" was a superior method to prompting.

It should be noted that the mediators for the second group, by virtue of having been selected directly by the learner, were obviously more strongly associated with the stimulus term for these learners than they were for the third group. Suppose that the third group had previously been taught to associate this mediating word with the stimulus term and also with the response term. It seems likely that under these circumstances prompting the subjects of the third group with the mediating word would have produced results just as effective as permitting them to select their own mediators.

The third area of research which is relevant is the research on learning set. In this area the effects of brief verbal instructions (or cues) upon learning, retention, and transfer are often studied. These studies used independent variables which are closely related to the independent variable of this project and, therefore, some of them will be individually reviewed below.

Maier (1930), with adult subjects, studied the role of "direction" in problem solving. His double pendulum problem was solved by eight of the 22 subjects in the direction group. Only one of 62 subjects solved the problem without the added cue: "Observe how easy the solution would be if you could only hang the pendulums from two nails in the ceiling." Providing a cue resulted in improving the problem-solving process.

Wittrock, in several experiments, found that with adolescents and adults a general cue can increase the learning of the cued principles. This was true whether the subject matter content was principles of 1) economics (1963a), 2) Buddhism (1963b), or 3) history, American government, and English (1962).

Luchins (1942), in a very well-known study, showed an important difference between adults and children in their uses of a general cue. The subjects who were taught a specific method of solving a water-jar problem continued to use the method even when a simpler one would have sufficed. A general cue, "Don't be blind," served to call the attention of adults and older children to the fact that there was a simple and efficient method; but this cue did not function for younger children.

From the above experiments it is clear that general cues, when they refer to knowledge previously acquired, can be effective with adults and adolescents. However, their effects upon children have not been established.

There have been studies which used cues that are similar in type to the class cue used in the present project. Bensberg (1958) used 60 male mentally defective subjects in an association problem situation. The task was to learn which of three buttons was associated with a verbal or pictorially-presented concept. An appropriate set (to look for form) and an inappropriate set (to look for color) were used. His hypothesis, that transfer would be positive with appropriate mediating responses and negative with inappropriate mediating responses, was strongly supported.

Wittrock (1964) in a study on the cueing of rules of cryptography found the class cue, the rule, to produce the greatest learning and transfer. Underwood and Richardson (1956) found that information about particular concepts or classes resulted in rapid learning. "Unrestricted instructions" gave the subjects nothing about the nature of the concepts, but they were told to vary their responses from trial to trial. "Partially restricted instructions" gave the subjects the responses needed to form the concepts. Simple ways to describe common objects were discussed by the experimenter. "Completely restricted instructions" gave the subjects the six correct concepts or classes: large, small, white, soft, smelly, rough. The subjects were allowed to study these and to keep them before them during the experiment. The greater the amount of information given to the subject concerning the content or nature of the concepts to be learned, the more rapid was the acquisition of concepts.

Ewert & Lambert (1932) studied the learning of a task which involved moving, in the least possible number of moves, circular cardboard discs from a given arrangement to a second, specified, arrangement. The experimenters measured the number of trials, the number of manipulatory movements, and also the amount of time necessary to produce the correct response. "Minimal," "standard," and "maximal" instructions were given to different groups of students. Increasing the amount of instructions resulted in increased learning as measured by all of the above criteria. Further, increased instructions resulted in a very definite increase in the variability of performance by the subjects. Performance was positively and highly related to intelligence. Solving a somewhat complex problem was shown to be helped by specific and detailed cues which contained information relevant to the problem.

From the above sample of related research, there is some reason to hypothesize a positive relationship between the specificity of the cue and the specificity of transfer. It is also plausible that any generalization about cues and dependent variables must be qualified by previous knowledge, history, intelligence, and possibly the age of the learner. In Chapter III below, the above hypothesis is presented in detail. The hypothesis was originally tested and supported with college students by Wittrock (1963c).

CHAPTER III. HYPOTHESIS AND EXPERIMENTAL DESIGN

Hypothesis

When the proposal for the project was prepared, the hypothesis stated that verbal cueing and transfer were related. However, the hypothesis stated a relationship only between the minimal or general cue and transfer.

From the theory and data of another study (Wittrock, 1963c), which were available shortly after the original hypothesis was created, it was possible to devise and to test a hypothesis more inclusive and more specific than the original one. The following hypothesis specifies relationships between general, class, and specific cues as independent variables, and learning, retention, transfer within a class, and transfer to new classes as dependent variables. When one type of verbal cue is compared with another, and when the correct response is a highly improbable one, the following relationship is expected.

> Hypothesis: When practice and reinforcement are provided for the responses indicated by the cues, the specificity of the verbal cue is directly related to the specificity of learning, retention, and transfer. Specific cues which prompt particular correct answers result in learning the specific instances of a class, but do not necessarily produce transfer. Verbal cues for a class of stimuli produce transfer to instances within a class. Cues more general than the class cue produce transfer to new concepts.

The above hypothesis does not imply that learners cannot generate concepts from specific cues, general cues, or from feedback. It does imply that with difficult problems, naive subjects learn and transfer in relationship to the cueing they receive, provided, of course, that other variables are held constant. It may be crucial to know at which level the other variables are held constant. For example, if knowledge of results for all groups includes all information supplied by the different verbal cues, they may inject no significant amount of variance. In short, it is impossible to know how the verbal cues, as one independent variable, may interact with other independent variables. It assumes that what is learned is what is practiced and reinforced.

The hypothesis can be explained with the basic mediation paradigm which states that after response B has become associated with stimulus A, and response C to stimulus B, stimulus A will evoke response C more readily than it would without this training. The middle term, B, is the mediator or common element connecting A and C.

In the usual school learning situation, the B-C associations consist of a repertoire of previously-learned responses, varying with the environmental and experiential backgrounds of the individual students. For example, if a child is asked to describe a "glubchup" without any further instruction (general cue), the guessing game which results may be classed as a process of "learning-by-discovery." Eventually, the responses labeled "wrong" will be eliminated and the responses labeled "right" will be integrated into the concept "glubchup." At the other extreme (specific cue), the child might be given a complete and detailed description of the concept and be required to commit all the appropriate details to memory. In both instances, the concept and its description are directly related: A is directly associated with C.

But if the child is told that a "glubchup" is a bird (A-B), and then asked to describe some of its salient features, a whole wealth of previously-formed associations to the concept "bird" ($B-C_{1-n}$) are now available to "glubchup" ($A-C_{1-n}$) without any additional instruction. The responses (C_{1-n}) to the stimulus (A) depend on the nature of the previously-formed ($B-C_{1-n}$) associations.

In sum, the hypothesis states a relationship between a cue and learning. If a cue is used to develop a concept, the cue should be most effective on a test when the concept discriminates right from wrong answers. If the criterion is more specific or more general than the class, then a more general or more specific cue, respectively, should produce the greatest transfer. The cue should match the criterion. (For further discussion of the hypothesis and for additional date to support it, see Wittrock, 1963c.)

The important independent variable of this investigation was the variation in verbal cues. For any given learning task, verbal cues were regarded as ordered along a continuum in terms of the breadth of the class which these cues controlled. Toward one end of the continuum would be found highly specific cues which control a narrow class of responses. At the other extreme would be found cues which control not only more responses but many classes of responses. For example, in a task involving identification of colored figures, "red circle" controls a small class of responses and in this context would be called a specific cue. The cue "red" controls a broader class and would be less specific while the cue "color" would be regarded as a general cue. The designation of a cue as specific or general is, of course, relative to the experimental task at hand.

It is possible, but not necessary, to regard a general cue as controlling several responses each of which in turn functions, as a mediating response, to produce an intermediate cue. Each of these response-produced cues could control other mediators, specific cues, that control a narrow class of responses. In this respect one can speak of a hierarchy of cues in which the most general are indirectly related to a large number of responses through the mediation of cue-producing responses which act successively to control more but smaller classes of behavior.

Experimental design

By presenting the children with problems and meaningful verbal cues about the correct responses one may be able to predict what the children will learn and transfer. However, such an attempt to predict assumes that the general cues are associated not only with many different responses but also with previously learned ways of eliminating many of these responses. A general cue does not give the child information about eliminating incorrect responses. It may only generate more possible answers than does a specific cue and can, therefore, be expected to increase the probability of a correct response on a transfer-to-~~new~~-concepts test. For a general cue to produce its maximum effect, it must be assumed that the children have learned how to eliminate incorrect answers. If the children have not learned "ways to discover", the effect produced by a general cue may be negligible or even detrimental, especially if the experimental training sessions provide little time for the children to learn how to eliminate incorrect responses.

With the limitation discussed above, this project attempted to predict and control learning and transfer by presenting primary school children with problems, meaningful verbal cues, and immediate knowledge of results. The problems and immediate knowledge of results were held constant for all groups and only the specificity of the verbal cues was varied. The basis for predicting learning and transfer was the single independent variable, the specificity of the verbal cue.

Three experiments were designed to test the hypothesis with primary school children. Apparatus was designed and constructed to provide fairly rigorous control over the stimuli and the recording of responses. The stimuli for each treatment group were placed on tapes and on 35 mm. slides and are exactly reproducible by other researchers provided they have the proper experimental apparatus. The responses of the children were automatically recorded to eliminate a common source of error. The different verbal cues, which comprised the only differences in treatment across the groups, were reduced to single words or brief and simple sentences to make apparent and simple the differences among the treatment groups.

In preliminary training and testing sessions, each child either learned or evidenced that he already knew the meaning of each verbal cue to be used later in the experiment. In all experiments, the children were individually assigned at random to the treatment groups after the preliminary training and testing were completed. The independent variable in all experiments was the specificity of the verbal cue. The dependent variables of each experiment were learning, retention, and transfer.

The experiments were divided into two phases. In Phase I the hypothesis was tested with abstract and unfamiliar materials after five pilot studies were carried out to develop abstract materials of appropriate difficulty and interest for young children.

In Phase II, the hypothesis was tested in two separate experiments, each of which used meaningful subject matter (mathematics and English) commonly taught in elementary schools. Each of the experiments of Phase II was also preceded by a series of pilot studies to determine material and procedure appropriate to test the hypothesis with elementary school children.

The procedure in each experiment consisted of three separate parts. First, preliminary training and testing was provided to insure that the children knew the information prerequisite to solving problems in the experimental sessions. In the experiment of Phase I, Abstract Materials, this preliminary training involved several months because none of the children knew the French vocabulary or the genders of the French nouns used as stimuli. In Phase II, where meaningful materials were used, the preliminary training and testing were curtailed to several days or several weeks.

The second part of the procedure was the experimental training. In each experiment the children were individually assigned at random to one of the treatment groups. All treatment groups were given exactly the same slides and "matching-to-sample" problems.

For example, in Phase II all children were shown a series of slides which presented a word at the top and five choices at the bottom. All children were to select one of the bottom choices because it was like the top word in a certain way. If the top word was a noun, then the correct bottom word was also a noun. While all children worked with the same slides and problems, the treatment groups differed from one another in that one group was given a general verbal cue (i.e., the children heard the taped voice say, "Part of speech".), while a second group was given a class cue (i.e., the children heard the taped voice say "Noun".). A third experimental group was given only a cue to find a bottom word to go with a top word. A control group which received no pre-experimental or experimental training was also included.

The third and final part of each experiment consisted of testing for learning, retention, and transfer. Transfer within a class was sampled in experiment 1. In experiments 2 and 3, transfer within a class and also transfer to a new class were used as dependent variables.

CHAPTER IV. PILOT STUDIES FOR THE FIRST EXPERIMENT: VERBAL CUES IN THE IDENTIFICATION OF ABSTRACT CONCEPTS

No. 1	The Association Value of Certain Stimulus Cards for Kindergarten Children.
No. 2	The Scaling of Nonsense Materials to be Used in Learning Experiments With Young Children.
No. 3	Teaching Paired-Associate Nonsense Materials to Kindergarten Children.
No. 4	Comparison of Two Methods of Establishing a Repertoire of Paired Associations.
No. 5	Transfer Through Minimal or Maximal Cueing of Mediated Responses.

PILOT STUDY NO. 1

The Association Values of Certain Stimulus Cards for Kindergarten Children

PROBLEM

For the major experiment of Part I, it was first necessary to determine what associations children at the kindergarten level already have to certain pictures. This information is important so that the stimuli used for the experiment would have known association values. As far as is known, this is one of the very few studies which has attempted to assess the association values of pictorial stimuli with young children for experimental purposes.

METHOD

Subjects. Nineteen kindergarten children, selected at random, were interviewed for the first part of this study. Four additional children were used for the second part.

Materials. There were 36 cards. On each card a picture had been drawn in black ink. For a few of the cards, the pictures represented everyday objects, e.g., dog, fish, and house. Cards in Category A contained pictures of nonsense animals. Cards in Category B represented non-objective designs, and, in Category C presented characters from the Hindi, Arabic, Japanese, and Hebrew alphabets.

Procedure. In the first half of the study, 19 children were interviewed individually by one investigator while a second acted as a recorder. Each child was asked to look at the 36 cards, one at a time, and report a single response to each stimulus card. As a result of these reports, 22 of the 36 stimuli were replaced by stimuli in which representational features were minimized. More time was spent with each child, and more than one response to each stimulus was obtained.

RESULTS

Part I. Children were usually able to give some response immediately to most of the original cards. Few cards produced no associations.

Wide variations were found, as was expected, among the children with respect to the number of associations. Some children responded immediately and frequently at length, to every card. Other children responded to only a few cards.

The stimuli in Category C elicited the highest number of associations (characters from foreign alphabets). Stimuli in Category A (nonsense animals) produced the next highest number of common associations. Stimuli in Category B (non-objective designs) brought out the fewest responses and in most cases it was a specific feature within the design to which the child was responding.

Part II. Very few definite associations were found to the revised set of stimuli, providing a supply of items with minimal association value. Each of the subjects in this part of the study was asked to indicate whether he liked or disliked each picture on the cards. Because of the small number of subjects, a scale of preference values could not be constructed, but 12 stimuli were "liked" by all of these subjects.

DISCUSSION

This exploratory study was valuable in the development of materials for the experiment for Phase I of the Project. Some of the problems involved in preparing abstract stimuli with minimal associations for kindergarten children were more clearly delineated.

PILOT STUDY NO. 2

The Scaling of Nonsense Materials to be Used in Learning Experiments with Young Children

PROBLEM

This study was a continuation of the work begun in Pilot Study No. 1. The object was to determine what associations, if any, young children already have to various pictorial and verbal stimuli, and to construct a scale of items of known values. Both number and variety of responses are assumed to be measures of the construct of meaningfulness. Underwood and Schulz (1960) have demonstrated that meaningfulness is an important factor in the learning of responses.

Although scaled nonsense materials are available for use with adult subjects (Glaze, 1928; Noble, 1952) at the present time there are no similar scales based on the responses of young children.

METHOD

Subjects. There were two groups of children, 53 in all; 25 boys and 28 girls. The ages ranged from 60 months to 109 months (average age 84.9 months). The first group of 25 children (60 to 84 months, average age 76.0 months) had completed at least a half year of first grade. The second group of 28 children (79 to 109 months, average age 93.0 months) had all completed the first grade and some of them one or two terms of the second grade. No information was obtained as to measures of intelligence.

Materials. Two types of materials were presented to all the children. The first type was pictorial and consisted of 64 black-and-white drawings on 4" x 6" unlined white cards. They included abstract designs composed of lines, circles, squares, etc., from Hindi, Arabic, Hebrew, and Japanese alphabets; abstract pictures resembling known objects or animals; and pictures of familiar objects such as a dog, a house, or a flower.

The second type of material was verbal. It was composed of a list of 48 two-syllable nonsense terms (dissyllables). The decision to use two-syllable terms rather than the usual consonant-vowel-consonant nonsense syllable was based on two considerations. First of all, it is possible to have a greater variety of letter arrangements, thus increasing inter-item discriminability. Secondly, it is more closely related to the echoic naming habits of young children (e.g., ma-ma, choo-choo, bow-wow, dog-gie, hors-ie, etc.).

The dissyllables used were based on the list scaled by Noble (1952), but modified so that, over the entire list of 48 terms, each of the alphabetic sounds was used not less than two nor more than four times at the beginning, middle, or end of a word.

Procedure. A. Pictorial Stimuli: First Session. The 64 cards were arranged in a stratified random order and divided into two sets of 32 stimuli. They were laid out on two tables in such a manner that only one table of cards could receive the full attention of the child. On the first day of the study, the experimenter was introduced to the group of children. They were told that the experimenter had prepared a number of pictures for children and wanted to know whether they liked them or not, and what they thought of them. It was emphasized that this was not a test and there was no right or wrong response. One at a time they were conducted into a neighboring room and seated at one of the tables where the cards had been laid out. Each child was told:

> "Look at all the pictures on this table. Take your time and make sure that you have considered all of them. When you see one you particularly like, pick it up. I want you to pick out the ten* pictures you like best. You can count to ten*, can't you? Of course you can! When you have picked up the ten* pictures you like best, bring them to me."

While the child was examining the first set of stimuli, the experimenter made out the record card and kept busy in other ways to give the child a feeling of freedom while he was making his decisions. When 10 pictures had been selected, the child was instructed to go to the other table and select the 10 pictures he liked best of that group. During this time the experimenter entered the numbers of the 10 pictures selected on the child's record card. When the child brought the second group of "liked" pictures to the experimenter, he was instructed to go back to the first table and choose the 10 which he disliked the most. Since the liked pictures had not been returned there was no possibility of selecting the same picture as both liked and disliked in the same experimental session. After the process had been repeated at the second table, the child was asked to sit down next to the experimenter and look at the cards (40) he had selected.

Each of these cards was shown individually. The child was allowed to hold the card, but he was told not to turn it around or look at it except from the pre-determined point of view. He was told:

> "Look at this picture. What do you think of when you

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*With younger children this instruction was modified to "five", and two groups of five pictures were requested.

> see it? Does it remind you of anything? Does it make you feel anything?"

If there was hesitation, the child was urged:

> "Just say anything... whatever you are thinking right now."

If the response given was "It's a design," the child was told:

> "Yes, it _is_ a design. But there are many pictures which are designs. How can we tell this design from the other ones? What does this design make you think of?"

If the child persisted with his response, repeating that it was "just a design," this was recorded as the response. With the two groups of older children a response was obtained for every stimulus.

The experimental session took from 10 to 20 minutes. At the end of the period, the child was sent back to his class and asked to send in the next child to look at the pictures. This provided time for the preparation of at least one of the tables. The next child was given the instructions indicated above. While he proceeded to pick out the liked pictures at the first table, the second table of pictures was arranged. The order of presentation of the tables was alternated so that half the group saw one table of stimuli first and half the group saw the other table of stimuli first. Reactions to the chosen pictures were obtained from all the children before the sessions with the verbal stimuli were initiated.

Procedure. B. Verbal Stimuli. The 48 dissyllables were arranged in random order in two lists, "A" and "B", of 24 words each, and were alternately presented from top to bottom and from bottom to top, varying the procedure with each of the two lists so that there were four possible orders of presentation: "A", top to bottom, and "B" top to bottom; "A" top to bottom and "B" bottom to top; "A" bottom to top and "B" top to bottom; "A" bottom to top and "B" bottom to top. Each child was told:

> "I'm going to say a word and I want to hear you say it after me. Then I want you to tell me what you think of when you hear that word. Listen carefully: '(WORD)' Say: '(WORD).' Good! Now, what do you think of when you hear the word '(WORD)?' Just say anything you happen to be thinking of right now."

After the last instruction, there was a pause for the child to respond. If he did not do so within five seconds, the next word was presented, using the same procedure.

Procedure. C. Pictorial Stimuli: Second Session. After the reactions to the verbal stimuli had been recorded, the child was led to one of two tables on which the pictorial stimuli had been arranged as in the first session. This time the child was asked to select the 10 he liked best from one table and bring them to the examiner. The numbers of the items selected were quickly recorded and the cards replaced while the child was selecting the 10 best-liked pictures from the second table. He was then told to return to the first table and select the 10 pictures he disliked the most. Since the liked pictures had been returned to the table, it was now possible for him to select the same picture as both liked and disliked. During this session there was no attempt to obtain a second set of verbal associations to the pictures.

RESULTS

Pictorial Stimuli. The meaningfulness of a stimulus picture was evaluated according to two criteria: (a) selection-frequency, and (b) verbal association value (see Table I). The scale based on the selection criterion was called the "Preference Scale," and the one based on the verbal responses the "Association Value." Actually, both scales were attempts to rank the items on the dimension of "Meaningfulness."

The preference scale was a simple rank-ordering of the total times each item was chosen, regardless of whether the basis for choice was like or dislike. It was presumed that the more meaningful a picture was, the more likely it was to be selected. Conversely, the more a picture was selected, the more meaningful it was judged to be. On the other hand, if a picture was infrequently selected it was concluded that that item was low in "drawing-power" or association value.

The question was raised as to how reliable these selections were. Was it justifiable to attribute "meaningfulness" to behavior which might perhaps be more aptly described as random? To test the hypothesis that item-selection was a dependable measure (setting aside here the question of how valid it might be as a measure of the construct of meaningfulness), a coefficient of consistency was computed. The proportion of children who responded to the same picture in the same way at both the first and second sessions was compared with the maximum number of times that any picture could have been selected or rejected. The overall coefficient of consistency for the combined group was 86.6%. However, the coefficient for the younger group was 82.6%, and that of the older group was 90.9%. The reliability of the difference between the two groups was not tested, but it is quite likely that stability of response is an age-related function, more experience providing a larger repertoire of mediators with which to form associations.

The immediate object of this study was to design a scale of materials which could be used with young children at the primary level. Would the same scale be applicable from kindergarten through second grade? If a high degree of correspondence between the responses of the older and younger groups could be demonstrated, then the question could be answered in the affirmative. Separate rank-order scales of preference were constructed for the two groups, and a rank order correlation was computed. A rho of .756, $t=9.10$, $p<.001$, was found. This was high enough to justify combining the data from the two groups and constructing a single scale.

The "Association Scale" was based on the ratio between the number of times any specific response was made to a particular picture and the sum of the number of different responses given plus the total number of responses possible. The rank order correlation between the preference rank and the meaning rank was .88, which seems to indicate that both scales are ranking the picture stimuli along similar or related dimensions (see Table 1).

Verbal Stimuli. Unlike the pictorial items, to which all the children were urged to respond regardless of how long they took, a five-second time limit for responding to the nonsense terms was set. The formula used to compute an index of meaningfulness for the words was analogous to that for the pictures. The total number of responses given was divided by the number of different responses plus the total number of responses possible (see Table 2).

In both cases it was felt that simply to divide the total number of responses made by the total number of responses possible (the method used by Noble) did not sufficiently discriminate the stimuli. Thus, if a response were given every time a stimulus was presented, that item would have an index of 1.00, which would be the highest value possible. At the other end of the scale, if no response was ever given, the numerator would be 0 and hence the index value would also be 0.

However, if responses were produced 100 times out of 100 presentations, and if each of these 100 responses were the same word, that item should not be equally meaningful with another item receiving 100 responses, every one of which was different. Two dimensions were being considered: meaningfulness and stereotypy of response.

Several other formulas were tried out, one of which involved only the ratio of number of responses to number of possible responses. Rank order correlations were computed. The correlations among the various ranking methods were all above .90, with a high degree of dependability. With only a few of the items was there a considerable difference in rank order as a result of the type of formula used to determine M. The effect of including the "number of different responses" factor can be seen in Table 2, where the two scales are compared.

DISCUSSION

A great deal more information was gathered than was used in constructing the tentative scales presented in Tables 1 and 2. The number of times an item was selected as liked or disliked in both the first and second experimental sessions by a group as a whole, not by the same individual children, was ranked and correlated. The rho for the older group between first and second choices was .807, t=10.78, p<.001; that of the younger group was .812, t=10.94, p<.001. These rhos are encouragingly high.

SUMMARY

This pilot study provided tentative scales for pictorial and verbal nonsense materials. From these scales it was possible to select items of known association value for the next pilot study.

TABLE I

SCALE OF PICTORIAL STIMULI

Picture Number	Preference Rank	Meaning Rank	Meaning Index	Picture Number	Preference Rank	Meaning Rank	Meaning Index
1	42	48	.3077	20	37	50	.3209
2	2	2	.1176	21	37	37	.2783
3	27	8	.1765	22	46	47	.3051
4	13	10	.1870	23	21	30	.2613
5	43	41	.2857	24	24.5	28	.2414
6	60	60	.3929	25	32.5	33.5	.2727
7	45	36	.2778	26	1	1	.1167
8	54.5	55	.3600	27	8	22	.2213
9	56.5	49	.3130	28	50	52	.3394
10	24.5	25.5	.2397	29	18	4	.1583
11	5	3	.1557	30	64	59	.3840
12	7	19	.2177	31	30.5	25.5	.2397
13	40	31.5	.2619	32	30.5	21	.2203
14	32.5	43	.2920	33	13	6	.1707
15	52	51	.3281	34	9.5	16	.2066
16	18	13	.2016	35	34.5	42	.2893
17	60.5	62	.4259	36	49	38.5	.2823
18	35	16	.2143	37	37	31.5	.2619
19	48	53	.3525	38	6	7	.1736

TABLE I (cont.)

Picture Number	Preference Rank	Meaning Rank	Meaning Index	Picture Number	Preference Rank	Meaning Rank	Meaning Index
39	27	46	.3025	58	27	17	.2080
40	58	53	.3510	59	37	29	.2537
41	13	23	.2295	60	16	24	.2350
42	63	61	.4174	61	53	57	.3761
43	29	33.5	.2727	62	44	38.5	.2823
44	41	45	.3015	63	20	5	.1639
45	60.5	63.5	.4404	64	47	35	.2761
46	13	15	.2031				
47	51	44	.3006				
48	9.5	13	.2016				
49	13	9	.1803				
50	23	20	.2180				
51	62	63.5	.4404				
52	34.5	40	.2846				
53	54.5	54	.3540				
54	16	11	.1933				
55	22	27	.2400				
56	3.5	13	.2016				
57	56.5	56	.3636				

TABLE II

A SCALE OF TWO-SYLLABLE NONSENSE WORDS

Word	Index I	Rank I	Index II	Rank II	Word	Index I	Rank I	Index II	Rank II
hoyev	.333	1	.472	1	perrule	.443	25	.660	27
ulna	.347	2	.491	2.5	laytuk	.446	26	.623	18
volvap	.355	3	.509	4	icon	.447	27	.642	23
voheb	.359	4	.528	5.5	mooah	.466	28	.642	23
hujuj	.382	6	.491	2.5	delper	.471	29	.774	46
balap	.382	6	.547	8	negeye	.486	31	.642	23
sagrole	.382	6	.547	8	capoot	.486	31	.679	29.5
yompub	.385	8	.566	11	gojee	.486	31	.736	39
natrix	.389	9	.528	5.5	atter	.493	33	.660	27
quelstrom	.392	10	.547	8	chuckwee	.500	35	.736	39
rennex	.400	11	.604	14.5	meerdon	.500	35	.736	39
foozik	.411	12	.566	11	xboo	.500	35	.755	42.5
loodis	.412	13	.660	27	jayvaj	.514	37.5	.698	32.5
yartum	.417	14	.566	11	zeyelef	.514	37.5	.717	36
quipso	.418	15	.623	18	turbid	.533	39	.755	42.5
elpej	.420	16	.642	23	welki	.543	40	.717	36
odekoo	.423	17	.623	18	jetzim	.552	41.5	.698	32.5
polef	.429	18	.623	18	runyez	.552	41.5	.698	32.5
tarcheye	.430	19	.642	23	widgeon	.554	43.5	.774	46
bysviss	.431	20	.585	13	argo	.554	43.5	.774	46
oofeg	.438	21	.604	14.5	fellop	.556	45	.755	42.5
somaitch	.439	22	.679	29.5	zoomap	.606	46	.755	42.5
ugugh	.440	23	.623	18	davit	.633	47	.717	36
koopay	.441	24	.698	32.5	gamick	.662	48	.811	48

Index-Rank I =Total Responses/Different Responses + Total Possible
Index-Rank II=Total Responses/Total Possible

PILOT STUDY NO. 3

Teaching Paired-Associate Nonsense Materials to Kindergarten Children

PROBLEM

The object of this pilot study was to determine (a) whether children at the Kindergarten-Primary level are capable of forming associations (word-word; word-picture; picture-picture) using nonsense materials and (b) the most effective method for effecting such learnings.

METHOD

Subjects. There were 32 first-grade students in the group. The intelligence indices ranged from 90 to 136, with an average I.Q. of 110.8. Ages ranged from 76 to 85 months, with a median age of 80 months.

Materials. For the first phase of this pilot study, the child associated each of two groups of five nonsense syllables with a label, another nonsense term. All 12 words were chosen on the basis of low association value from a list of 48 such words which had been tried out with other first graders. Both groups of words were equated for interest and association value. For the method of forming the syllables and determining the values, see Pilot Study No. 2 above.

Apparatus. The equipment consisted of 10 three-sided individual booths, constructed of sound-absorbent wallboard. Each booth had a three-button response panel, a microphone, and a pair of earphones. The earphones were wired so that one ear received the output of the tape recorder, and the other ear received the feedback from the microphone. The latter was desirable for reinforcement as well as to discourage over-loud responding.

Although the response panel was not essential to this part of the experiment, its interest value was clearly obvious. The children were instructed to press the button for the green light when they were ready, and the button for the red light when they were finished.

Procedure. The 32 children had been divided by their teacher into three groups according to reading ability, and these groups were retained for the study. Each group was sent into the experimental room, across the hall from the regular classroom, during the 15 or 20 minutes which comprised the seat work portion of their reading period.

The material to be learned was presented in a discursive program recorded on tape. It was played on a tape recorder, which was connected by the control panel to each of the 10 pairs of earphones. The children were to respond to the instructions on the tape. On the seventh day the tape was not used. Instead, the experimenter personally directed a review of the word-groups and then administered a 20-item test.

RESULTS AND DISCUSSION

The average score for the 28 children present was 11.0. There was little difference between the scores of the first two reading groups (11.5 and 12.0 respectively), but the average score for the third group was 9.4. There was also an apparent correlation between performance in this task and intelligence level.

The results of the tests indicated that the children had not learned the word associations. Evidently this discursive program was not a successful method of teaching paired associations with nonsense materials.

PILOT STUDY NO. 4

A Comparison of Two Methods of Establishing A Repertoire of Paired Associations

PROBLEM

In the course of Pilot Study No. 3, it was demonstrated that none of the children had been able to learn the initial learning task, which consisted of learning ten paired associations, using two-syllable nonsense words or dissyllables. Five of these were each separately paired with the same label or category word, another dissyllable, and a second group of five different words were each paired with another category label. Ten pairs of associations were thus constructed, such that one set of five pairs had one common response term, and the second set of five pairs had a different common response term.

The question was raised as to whether this task was too difficult for first-grade children. Could some other method succeed where a "discursive" method has failed? Perhaps a repetitive, rote method of presentation would be more suitable to the material. Would the learning be facilitated if a visual stimulus accompanied the spoken word? Paired-associate nonsense syllable learning experiments have always used older subjects, and the alphabetic representation of the syllable has usually accompanied the oral stimulus.

This pilot study was an attempt to determine whether (a) young children could learn paired- associates involving nonsense material if a repetitive, rote-method was used and (b) if this learning could be facilitated by the presentation of visual stimuli with which the nonsense terms would be associated.

METHOD

Subjects. There were two groups of children, 26 in all, ranging in age from 82 months to 94 months (average age 87 months), with Pintner-Cunningham I.Q. from 93 to 123 (average I.Q. 100.7). At the beginning of the study there were 15 children in each group.

Materials. The 12 nonsense terms used were chosen on the basis of low association value from a list of 48 such words which had been tried out with other first graders (Pilot Study No. 2) and found to be of approximately equivalent interest and association value. The pictures to which the words were associated were selected from a set of 64 on the basis of association value. The scale was determined by preference rank (number of times chosen) and meaningfulness (proportion of responses to different responses).

In each of the two sets of five pictures used in the present study, two had high association value, one was intermediate, and two were low in association value.

EXPERIMENT I

Procedure. The children were divided into two groups. The first group was identified as the "Audio-Only" group. With this group, the nonsense words were paired by rote repetition, using oral presentation alone. On the first day, two sets of four nonsense terms were introduced, three different words each separately paired with the same fourth term. Six different word-pairs were thus formed, three having one common response term and three having a different common response term. The pairs were intermixed and presented in random order, rapidly paced.

No new words were introduced the second day, while the associations between the previously-presented word-category pairs were being strengthened. On the third day, two additional words were introduced, one paired with one response term and one with the other. After five repetitions of each of the new pairs, they were interspersed in random order with the other pairs and practiced for 10 minutes. A similar procedure was carried out on the fourth day, when the fifth set of word-pairs was introduced. A test was then administered to determine how effectively the associations between the words and categories had been established. The children had to choose which one of the two label terms was associated with each of the ten nonsense terms.

The second group was identified as the "Audio-Visual" group. This group was exposed to the same word pairs as the first group, but when each word was presented orally, a picture was projected on a screen. Two words, one from each category, were associated with each picture. Three pairs of words and three pictures were presented on the first day. One new picture was associated to a new pair of words on the third and fourth days. The same test was then administered.

RESULTS

The mean score (6.73, σ 2.43) of the Audio-Only group was dependably superior to that of the Audio-Visual group (Mean 3.45, σ 2.52). A t-test for the difference between random means gave a value of 3.68 with $p<.01$. It was felt that this difference might be attributed to the fact that the Audio-Only group was learning the nonsense words alone, whereas the Audio-Visual group was learning two sets of new material (pictures and words). Moreover, they were learning two different names for the same picture.

EXPERIMENT II

Procedure. For this experiment, the Audio-Visual group spent each practice session strengthening the associations of words to categories and words to pictures. The Audio-Only group was now taught to associate the 10 nonsense terms to five pictures, in the same procedure which had been used with the Audio-Visual group. Three word-pairs were associated to three pictures the first day; one new word-pair and picture were introduced on the third and fourth day.

On the fifth day, all the children were given two tests. The first was a picture identification test consisting of 20 items. The five pictures which they had learned to identify were placed under a protective cover on a master sheet. Ten sheets of paper of three different colors, arranged so that each successive sheet was of a different color, were cut out to expose the five pictures, and placed over the master sheet. The children were given black lead pencils and instructed to place an X on the appropriately colored page under the picture which was called by the name spoken by the experimenter. The two names to each picture were given once, the first time through the test booklet. The children were then instructed to return to the first page and their black lead pencils were replaced by red lead pencils. The second time through the booklet the appropriate picture was indicated by marking a red X directly below the picture. Thus each picture was to be identified four times, twice by one name and twice by the other name. No credit was given unless the picture was correctly identified both times for each name.

The second test was similar to the test given at the end of the first week. Each child had to select the proper label or category for each of the

10 nonsense dissyllables. Again, no credit was given unless the correct response was selected both times.

RESULTS

As indicated above, there was a reliable difference between the means of the two groups on the first test. However, at the end of the second week, the difference between the two groups on the picture identification test and the word-category association test was not reliable. Because there was such a large difference in the number of children in each group (four had dropped out of the Audio-Visual group) and because information was not available as to the mental level of all the children in the second group, six matched pairs were selected for analysis. A _t_-test for matched samples gave a value of 5.31 ($p<.01$) for scores on the test which had been given at the end of the first week. There was no reliable difference between the matched pairs of both groups for either the picture identification test or the word-category association test. The total scores of the matched pairs was found to be significantly different ($t=2.94$, $p<.05$), but this probably reflected the differences in the first week's test.

No statistically significant difference could be attributed to the association values of the pictorial stimuli.

DISCUSSION

Only three of the 26 children were able to associate the 10 nonsense terms to the category labels after four daily sessions of approximately 15 minutes each. It was also demonstrated that verbal training alone was superior to training which involved the association of the words to a picture . If, however, the ultimate objective is to teach word-picture associations, then either approach is equally effective.

PILOT STUDY NO. 5

Transfer Through Minimal or Maximal Cueing of Mediated Responses

PROBLEM

The same group of children used in Pilot Study No. 3 were used to determine: (a) whether young children could form associations between nonsense words and pictures, and (b) whether this repertoire could be used in a concept-formation experiment under different treatment conditions--specific cueing, mediator cueing, or no cueing other than minimal basic instructions. In effect, this amounted to a preliminary tryout of the materials and methods to be used in Part I of the experiment proper.

METHOD

Subjects. Although 32 children were in the class at the beginning of the summer session, drop-outs and absences reduced the number who could participate in the final test to 27. These children ranged in age from 76 months to 85 months, with an average age of 80.4 months. The mental levels ranged from I.Q. 93 to I.Q. 136, with mean I.Q. 112.7. The means and sigmas for age and I.Q. of the three treatment groups approximated the means of the total group.

Materials. Two types of learning materials were used (see Pilot Study No. 4). The verbal material consisted of 12 nonsense dissyllables (nonsense words of two syllables), chosen from the low-association-value half of a list of 48 such terms. These terms had been scaled according to the number of responses obtained from a different but similar group of first grade children (Table I).

TABLE 1

ASSOCIATION VALUES OF NONSENSE TERMS

Dissyllable Category		Association Value	Dissyllable Category		Association Value
QUIPSO		.418	TARCHEYE		.418
bysviss	dropped	.431	oofeg	dropped	.438
foozik	B-2	.411	yartum	C-1	.417
yompub	dropped	.385	balap	C-2	.382
sagrole	B-1	.382	voheb	dropped	.359
hoyev	B-3	.333	ulna	C-3	.347
Mean Category "Q"		.3933	Mean Category "T"		.3935

The pictorial materials included representations of familiar items such as a fish, dog, and snake (high association values), semi-abstract designs similar to real objects (intermediate association values), and non-objective designs of lines, curves, and squares (low association values) (Table 2).

TABLE 2

PREFERENCE (I) AND ASSOCIATION (II) RANK ORDER

AND DESCRIPTIONS OF PICTORIAL MATERIALS

Item No.	Description	Rank I	Rank II	Item No.	Description	Rank I	Rank II	Item No.	Description	Rank I	Rank II
45	Snake	60.5	63.5	43	Hebrew letter	29	33.5	11	Crossed curves	5	3
51	Fish	62	63.5	13	Worms	40	31.5	26	Pipes	1	1
61	House	53	57	21	Flags	37	37	38	Circles	6	7

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30	Diamond	64	59	25	Chinese hats	32.5	33.5	2	Dots and curves	2	2
17	Dog	60.5	62	37	Bird	37	31.5	33	Bows	13	6

Apparatus. Ten three-sided individual booths, constructed of sound-absorbent wallboard, were used. Each booth had a three-choice, button response panel, a microphone, and a pair of earphones. The earphones were wired so that one ear received the output of the tape recorder and the other ear received the feedback from the microphone. This latter feature was incorporated both to provide reinforcement as well as to discourage the children from responding too loudly.

In the first part of the study, a Wollensak tape recorder was used, with the stimulus words presented in a discursive, taped program. In the remainder of the study, the pre-recorded tapes and microphones were not used.

The pictorial materials were presented in individual booklets, with the pictures, reproduced in black on white photographic paper, mounted on 8 1/2" x 11" sheets of colored paper, under protective plastic covers. The contents of the booklets, and the booklets themselves, were adapted to meet the requirements of the experimental situation. A Kodak Carousel slide projector was used to present 2" x 2" black-and-white slides of the pictorial material in the later phases of the study.

Procedure. The children in this B-1, A-1 class had been divided by their teacher into three groups according to reading ability. This arrangement was both suitable for the study and convenient for the teacher and was therefore retained for the first phase. Each group was sent into the experimental room during the 15 or 20 minutes which comprised the seat work portion of the reading period.

The study was divided into two major phases: the pre-experimental, during which a response repertoire was to be built to criterion level for all the participants; and the experimental, during which the material would be used to develop a concept or principle under the three treatment conditions (Table 3).

TABLE 3

MEDIATION PARADIGM

PRE-EXPERIMENTAL TRAINING

(word)	(category)	(word)	(picture)	(word)	(picture)
B_{1-3}	quipso	B_{1-3}	A_{1-3}	B_{1-3}	D_{1-3}
C_{1-3}	tarcheye	C_{1-3}	A_{1-3}	C_{1-3}	E_{1-3}
Step 1		Step 2 and 3		Step 4 and 5	

TREATMENTS

1. Minimal Instructions:

A_1 (Picture only)----- B_1 --- Q --- B_1 ------ D_1
----- C_1 --- T --- C_1 --- E_1

A_2 ---------------- B_2 --- Q --- B_2 ------ D_2
----- C_2 --- T --- C_2 --- E_2

A_3---------------- B_3 --- Q --- B_3 ------ D_3
----- C_3 --- T --- C_3 --- E_3

2. Class Cue:

A_1 + Q B_1 ------------------- D_1
(Picture and category)

A_2 + Q ----- B_2 ------------------- D_2

A_3 + Q ----- B_3 ------------------- D_3

3. Specific Cue:

$A_1 + B_1$ ----------- D_1

(Picture + Picture name)

$A_2 + B_2$ -------- -- D_2

$A_3 + B_3$ ----------- D_3

The first part of the pre-experimental training was devoted to establishing associations between each of one group of five nonsense dissyllables to a similar dissyllable (quipso) which served as a category label, and each of a second group of five nonsense dissyllables to another dissyllable (tarcheye) which served as a second category label. Two "families" or categories of five members each were thus established (see Pilot Study No. 2). Because of the difficulty of learning 10 pairs of associations, two pairs were dropped at this point. (See Table 1.)

The second part of the pre-experimental training developed associations between pictures A_{1-3} and words B_{1-3} as well as between the same pictures A_{1-3} and words C_{1-3}. All the B-words belonged to the Q (quipso) family and the C-words belonged to the T (tarcheye) family.

Nine booklets, each containing three copies of three different pictures A_{1-3} were used. In three of the booklets, the three pictures were of high association value; in three they were of intermediate association value; and in three they were of low association value. (See Table 2.) The color of the booklet cover (yellow=high, red=intermediate, and blue=low) indicated the association value level. The booklets were assigned at random to the members of each group, but because of the basis on which the groups had been formed this meant that three children at each level of ability had booklets at the three levels of association value. The groups were told:

> "Turn to the (color) page. The picture on this page has two names. One name for this picture belongs to the (Q) family. It is (B_1). The other name for this picture belongs to the (T) family. It is (C_1). Look at the picture and say: (B_1). (Pause) Now look at the picture and say: (C_1). (Pause) When I say (Q) you say (B_1). When I say (T) you say (C_1). Ready, begin."

The rote naming of each picture was repeated four times. Then instructions were given to turn to the next page, which was of another, identifying color. The three different pictures were introduced in the same manner. Then the rote-association of the picture-naming response with the picture-stimulus was continued for the remaining pictures in the booklet, which included two additional copies of each of the three stimulus pictures.

When the last picture in each booklet was finished, the children were asked to return to the first page and the entire procedure was repeated twice. Thus, at each session, every stimulus picture was presented nine times. After one week, a picture identification test was administered (Table 4).

TABLE 4

PICTURE IDENTIFICATION TESTS

Reading Group	Association - Value Levels							
	High		Intermediate		Low		Total Group	
	Test A	Test B	Test A	Test B	Test A	Test B	Test A	Test B
1	44.2	70.0	40.0	34.0	58.3	70.0	46.7	55.5
2	50.0	51.5	62.5	56.5	69.1	73.5	60.8	60.5
3	52.5	50.0	35.8	53.5	45.0	40.0	44.2	48.0
Total Group	50.8	56.5	45.8	46.5	50.8	61.0	49.2	54.5

Note.--Test A consisted of 12 items; Test B consisted of 20 items.

TABLE 5

Arrangement of Pictures in Triptych Booklet 1 *

Cover Color	Color of Page on which Picture was Mounted		
	Page 1A	Page 2A	Page 3A
	Green	Red	Blue
Yellow (High)	45	51	61
Red (Intermediate)	43	13	21
Blue (Low)	11	26	38
	Page 1B	Page 2B	Page 3B
	Red	Blue	Green
Yellow	61	45	51
Red	21	43	13
Blue	38	11	26
	Page 1C	Page 2C	Page 3C
	Blue	Green	Red
Yellow	51	61	45
Red	13	21	43
Blue	26	38	11

* The numbers in the body of this table refer to pictures whose association values are given in Table 1, page 36.

The next three days were devoted to establishing the same associations in the reverse directions: B---A, and C---A. New booklets were constructed in the form of a triptych in which the three different pictures could be presented at the same time. Each of the three triptyches, labeled "A," "B," and

"C," contained the three stimulus pictures of one association-value level. No picture appeared twice on a sheet of the same color, nor twice in the same position. The position of the colored sheets was also varied. There were three sets of triptyches, one for each association level (See Table 5).

On the response panel, three pieces of tape, of the same colors as those of the pages, were placed under the response buttons. A different color was under each button. The directions:

> "Take the folder with the letter "A" on the front. Open this folder and look at the pictures. One picture is on a red page, one is on a blue page, and one is on a green page. Now look at the box with the buttons. Each button has a different color under it, one to match each of the pages. I'm going to ask you to find the picture I name. If it is on the red page, press the button over the red color. If it is on the blue page, press the button over the blue color. And if it is on the green page, press the button over the green color."

At this point a brief check for color recognition was made.

> "Let's see how well we all know our colors. Which button would you press if the picture were on the red page? If it were on the green page? If it were on the blue page?"

None of the children had any trouble finding the correct color, and so the instructions proceeded:

> "Now look at the three pictures. Find the picture called (name). If it is on a red page, press the button over the red color; if it is on the green page, press the button over the green color; and if it is on a blue page, press the button over the blue color. After you have pressed a button, a light will come on, on the top of the box. If it is green, you are right, but if it is red, you are wrong, so try again. What color paper is the picture called (repeat name) on?"

When all the lights on the master panel showed green, the instructions continued.

> "Yes, the picture on the (color) paper is called (name). Now look for the picture called (name). What color paper is this picture on? Press the button over the color which matches the color

of the paper the picture is on. If you get a red light, you are wrong, so try again."

This training continued for the six names of the three pictures in booklet "A." The children were then instructed to fold these booklets so that the letter "A" was on top, and to take the booklet labeled "B." The procedure was repeated for all three booklets. After the completion of booklet "C" all three booklets were repeated in the same manner. Another test was administered at this point (Table 6).

TABLE 6

PRE-EXPERIMENTAL TRAINING

Word-Category Associations (20-Item Test)		Picture Identification (D_{1-3} and E_{1-3}) (12-Item Test)	
Reading Group	Mean %	Reading Group	Mean %
1	57.5	1	73.1
2	60.0	2	64.1
3	47.0	3	33.3
Total	55.0	Total	57.1

The last type of pre-experimental training involved pairing the six nonsense terms each with a different picture, B_{1-3} to D_{1-3} and C_{1-3} to E_{1-3}. Since the same six pictures and nonsense terms were used for all the children, these were presented in a group situation, not in the individual booths. The six pictures were photographed and mounted on 2" x 2" slides and projected on a Kodak Carousel slide projector. There were five copies of each of the six pictures, so a random sequence of 30 slides was projected twice. This training was continued for three days.

For the B---D and C---E training, the six pictures were mounted in the triptych booklets. Because of the limitations imposed by the three-choice response panel, two pictures were mounted on each of the pages (Table 7).

TABLE 7

ARRANGEMENT OF PICTURES

IN TRYPTYCH BOOKLET 2

Page 1	Page 2	Page 3
Yellow: Top 17 Bottom 30	Black: Top 33 Bottom 25	Orange: Top 37 Bottom 2

The picture identification task was divided into two segments.

Preliminary training in pressing the right or left button was given. Also, when requesting the response, "right" was always paired with "top" picture and "left" with "bottom" picture. The first question was: "On what color page is the picture called (B_1)?" After the color response had been given correctly by all the children they were told:

> "Yes, (B_1) is the name of the picture on the (color) page. But there are two pictures on that page. Is (B_1) the top picture or the bottom picture? If it is the top picture, press the button on the right; if it is the bottom picture, press the button on the left. If you are correct, the green light will turn on; if you are incorrect, the red light will come on."

This procedure was repeated for all the pictures, the six stimuli being presented in three different random orders at each session. At the end of the fifth week, a test was given to determine whether the desired criterion levels had been achieved. (See Table 6.)

Although at no point had the criterion of three consecutive correct responses been reached, it was decided to proceed with this "dry run" and go to the experimental training before the summer term was finished. Three treatment groups, each consisting of nine children, were formed. In each of the treatment groups there were three children at three different levels of ability (as determined by I.Q. and teacher estimates of reading ability). Each of the three children in any one ability level had been trained with pictures of three different levels of association value.

For the experimental treatment, a new booklet of nine pages was developed. It consisted of three copies of three different sets of pictures, arranged so that there was one 4" x 6" picture in the upper half and four 1 1/4" x 1 1/4" pictures mounted in a row beneath the large picture. The top pictures were A_1, A_2, and A_3. The small pictures for picture A_1 included D_1, E_1, A_2, and A_3, arranged in stratified random order on the three pages containing the same pictures.

The child was presented with five different stimuli. The major stimulus was the large picture to which his attention was first directed. This stimulus would theoretically produce two implicit responses; a name belonging to category "Q" and a name belonging to category "T." The smaller pictures would also call forth implicit naming responses. One of the small pictures (D_1) would produce the B_1 category label of the large picture; another small picture (E_1) would produce the second category label (C_1) of the large picture. The other two pictures were simple distractors. The task for the child was to determine, in any one problem sequence, which of the two category labels was correct.

If the child selected the first picture having one of the names of the large picture, he might be right or wrong. If he were right, purely by chance, when the A_2 picture was presented and he again pressed the button of the first small picture having one of the names of the large picture, he would be wrong.

He would have to try out another hypothesis. If he selected the small picture with the second name of the top picture, he would be right. But if he selected the picture with the name of the A_3 picture, he would be wrong. Thus an order-sequence hypothesis would have to be rejected. Various other hypotheses might be tried out, until finally the correct principle (the picture to be selected must have the name associated with the correct category) would be "discovered."

On the first day of the experimental training, the correct response was the picture with the name belonging to category "Q." On the second day there was a reversal shift, and now the correct response was the picture with the name belonging to category "T."

All the treatment groups received the same basic instructions:

> "In the past few days you have learned something about these pictures. Look at the large picture at the top of the page, then look at the four small pictures beneath it. Look at all of them, then pick out the small picture which you think goes with the large one. If you pick the right picture, you will see a green light, but if you pick the wrong picture, you will see a red light. If you see a red light, choose another picture until you do get a green light."

From this point the instructions differed for each of the treatments.

No Help. After the basic instructions were given, the children were given time to respond. When all the green lights were on, the children were told:

> "Look at the picture with which you got the green light. Do you know why that was the right picture? Let's think about it for a minute. (Pause) All right, now let's turn to the next page and do the same thing."

This procedure was repeated for the 21 pages, so that each page of different pictures was shown seven times. No record was kept of the first day's responses.

If the principle had been derived after the first day's training, the response to the first picture on the second day should have been D_1 and therefore incorrect, because the No Helpgroup had no information that a shift had taken place.

Class Cue. In addition to the basic instructions, this group was given the category label "Q." It was told, "Remember, the top picture has a "Q" name. Choose the small picture that goes with it. Press the button for this picture." The visual stimulus (A_1) would evoke the implicit responses, (B_1 and C_1); the oral stimulus (Q) would be associated with B_1 and not with C_1, and the picture with the B_1 name should be more readily selected.

On the second day, this group was given the same instructions, but this time it was told: "Remember, the top picture has a (T) name. Choose the small picture that goes with it. Press the button for this picture."

Specific Cue. This group was given the specific word-prompt (B_1). "Remember, the top picture is called (name). The small picture that goes with it is called (name). Press the button for this picture." Theoretically, this group should achieve perfect scores on both the first and second training days. However, it would not necessarily be aware that there was any underlying principle involved.

Transfer Test. Two transfer tests were devised. In Transfer Test I, the same pictures were presented as in the two experimental training sessions. However, all the groups were given only the directions previously given to the "NoHelp"group, and "Q" was coded as the correct category.

Transfer Test II presented either a "D" picture or an "E" picture as the large picture, and three small pictures. D_1 on top would have as small pictures

D_2, E_1, and E_2. The top picture, D_1, should cue the response B_1, the small pictures should cue responses B_2, C_1, and C_2. Both B_1 and B_2 were associated with category "Q," whereas C_1 and C_2 were associated with category "T." The principle of selecting the picture with the same category name would have to be applied in order to select the correct response picture.

RESULTS

The results of the pre-experimental training are presented in Table 6. Because of the limited time available in the summer session and because there was no experimental precedent on which to base estimates of how long it would take young children to learn this type of material, the necessary criterion levels of learning were not attained. Some differences seem to be indicated by the mean scores, but because of the few subjects and the large standard deviations within groups, these were not statistically significant.

Although the difference in scores made with pictorial materials at the three levels of association value were not statistically significant, both high and low association value stimuli seem to offer less interference than intermediate association value stimuli. The only certain conclusion that can be drawn from the data of Table 6 is that the strength of the available repertoire was only slightly better than could be expected by chance. With this "chancey" repertoire, the results of the various experimental treatments are obviously suspect.

Table 8 presents the results of the test of experimental training under various treatment conditions, as well as the results of the two types of transfer tests. As could be expected, the Specific Cue group was dependably superior to both the Minimum Cue group and the Class Cue group. The task here was recall of the picture which had been associated with the nonsense term.

TABLE 8

EXPERIMENTAL TRAINING AND TRANSFER TESTS

Treatment Group		Experimental Training		Transfer Test I		Transfer Test II	
		Mean	Sigma	Mean	Sigma	Mean	Sigma
1. Minimal Instructions		3.56	2.11	12.9	4.43	11.4	4.68
	%	39.52		61.40		54.26	
2. Class Cue		3.44	1.58	13.6	5.32	12.0	4.85
	%	38.18		64.71		57.12	
3. Specific Cue		6.44	1.69	10.8	4.84	9.2	.97
	%	71.48		51.41		43.79	
		(9-Item Test)		(21-Item Tests)			

A 3 x 3 analysis of variance was made for each of the five tests. There were three treatment conditions and three I.Q. levels. The five tests were (a) Experimental Training, (b) Transfer Test I (number right), (c) Transfer Test I (Errors plus Trials to Criterion), (d) Transfer Test II (number right), (e) Transfer Test II (Errors plus Trials to Criterion).

The variance among the means on the Experimental Training test was statistically significant for treatment and for intelligence level ($p < .05$ and $< .001$). The combined score on Transfer Test I was also statistically significant ($p < .05$ level), for treatment.

DISCUSSION

This pilot study was valuable for two reasons. First, trying out the materials and testing various methods of presentation gave information about many procedural and equipment problems.

Second, it was learned that the interest of these first-grade children can be secured and retained for six weeks, working 15 to 20 minutes a day, even with nonsense materials. At the end of the six-week period, the children still eagerly came to the experimental sessions. However, three times through the same test booklet was about the maximum tolerance, before complaints of "Not again! " were heard. When a series of slides was projected, it could be repeated five and six times without the children becoming restless. Interest in the experimental situation could be maintained if a variety of materials was used.

Perhaps the most valuable information gathered from the present study was that it was extremely difficult to teach nonsense materials to kindergarten children. Some adjustment of the difficulty of the program for the experiment in Phase I was made in the light of these findings. For the experiment of Phase I, simple but interesting nonsense syllables, and pictures with which the children are familiar, should be used as stimuli.

In sum, the results of this pilot study show that children can become interested in learning unfamiliar types of material. Although not definitive, the results support the hypothesis that such imprecise terms as "discovery" and "insight" may be given operational definitions and can be experimentally manipulated.

CHAPTER V. THE FIRST EXPERIMENT: VERBAL CUES IN THE IDENTIFICATION OF ABSTRACT CONCEPTS

PROBLEM

Educators are often plagued by the problem of what types of verbal assistance to give to students during learning to obtain optimal transfer of training. There is need for research on discovery learning which: (a) in a classroom setting provides fairly rigorous control over the stimuli; (b) independently defines brief stimuli from the behavior they may produce; (c) controls the relevant, prior associations of the learners to the stimuli.

The present study attempted to provide these conditions. The objective was to predict and to control the effects upon transfer produced by general or specific verbal cues (single words or single brief sentences), which were spoken to the learners while they solved problems.

To predict the effect which these different types of verbal cues from E may have upon learning and transfer, it is important to know the prior, relevant associations which Ss have to them. In this study the relevant history of these cues was known because, in an extensive preliminary training period, E taught the kindergarten children a hierarchy of associations involving these foreign words. It was decided to use French nouns because of the results of the pilot studies described above.

Data and theory from an earlier study (Wittrock, 1963c) on the effects of verbal stimuli suggest that the kind of verbal cues used by a teacher to direct problem-solving affects learning, retention, and transfer. Specific cues which prompt a few particular correct answers can result in learning these specific instances of a class, but may not necessarily produce much retention or transfer. Cues for a class of stimuli can produce retention and also transfer to other instances within the class. Cues more general than the class cue can produce transfer to a wide variety of stimuli.

In the present study, it was hypothesized that, when Ss have appropriate histories to make cues meaningful, the greatest retention and transfer within a class of problems occurs when the name for the class (the class cue), rather than a more general cue or a more specific cue, is given by E while Ss solve problems of the same class. The class cue should reduce the information to be retained and should produce transfer because it has been associated with all the correct responses and only the correct responses. The more general words may cue some incorrect responses while the specific words may omit many correct responses. By the same reasoning, it was also hypothesized that the most specific cue should produce the most initial learning of the few specific associations which were taught.

METHOD

Procedure

Before the treatment groups were formed, the children were taught a hierarchy of associations which included the words which were later used, in the experiment proper, as cues to the problems. The different types of cues were related to each other in the hierarchy as follows: the general cue (article) was associated with two class cues (la, le) each of which was associated with six specific cues (French names) for instances of the class.

The treatment groups were then formed at random. The treatments were administered, and the learning and transfer tests were given. In detail, this procedure is explained below.

Preliminary training. To be certain that the relevant associations to the verbal cues were under experimental control, over a period of three months, 32 sessions of preliminary training were given to all children before the experiment proper began. Each session was 15-20 minutes in length. No more than one session a day was given to any one child. In the first five sessions, the children became accustomed to the apparatus and its operation. They learned to press the correct one of five numbered buttons when a similarly numbered picture appeared on the screen. This training provided the child with an overt response, a button press, to any picture numbered one to five.

In the remaining 27 sessions, a hierarchy of associations was taught as follows. All children learned the French names of 12 common objects and animals. The six nouns used in the experiment training were "la clef" (key), "la feuille" (leaf), "la voiture" (car), "le chien" (dog), "le chat" (cat), and "le bateau" (boat). The six nouns used on the transfer test were "la porte" (door), "la maison" (house), "la chemise" (shirt), "le bonbon" (candy), "le tambour" (drum), and "le livre" (book). The children also learned that each French name had an initial "la" or "le" sound. They were taught to say "la" or "le" and to discriminate "la" and "le" when a French name was spoken. Finally, they all learned to associate the words "la" and "le" with the word "article." Each association in the hierarchy was taught in both forward and backward directions. For example, with the 12 pictures and their

French names, each child learned to say "la feuille"[1] when presented with the picture of a leaf (picture-name) and also learned to select the picture of a leaf when he heard "la feuille"[2] (name-picture).

Tests were given regularly during the above preliminary training. To insure that the associations were well learned, two weeks of "vacation" were given. Then a 48-item test over the preliminary training was given to each child.

In summary, before the children were divided into treatment groups they were taught a structure or hierarchy of associations. The term "article" was associated with "la" and "le", each of which in turn was associated with six French nouns. Each of the 12 French nouns was associated with a picture.

Experimental training. The children were then ranked by IQ and were individually assigned by a stratified random method to the four treatments. A problem-solving task, which required use of the structure taught during the preliminary training, was presented. The children were shown slides containing three pictures, a model at the top and two alternatives below.[3] They were asked to select one of the two pictures at the bottom which matched the picture at the top. The basis for matching was always the gender of the French name of the top picture. One of the alternatives always had a masculine name and the other a feminine name. Right-left position of the gender was randomized.

With other content, three days of orientation to a matching-to-sample task were given. The experimental training proper then began and lasted two days. The treatment groups were given the following instructions each day.

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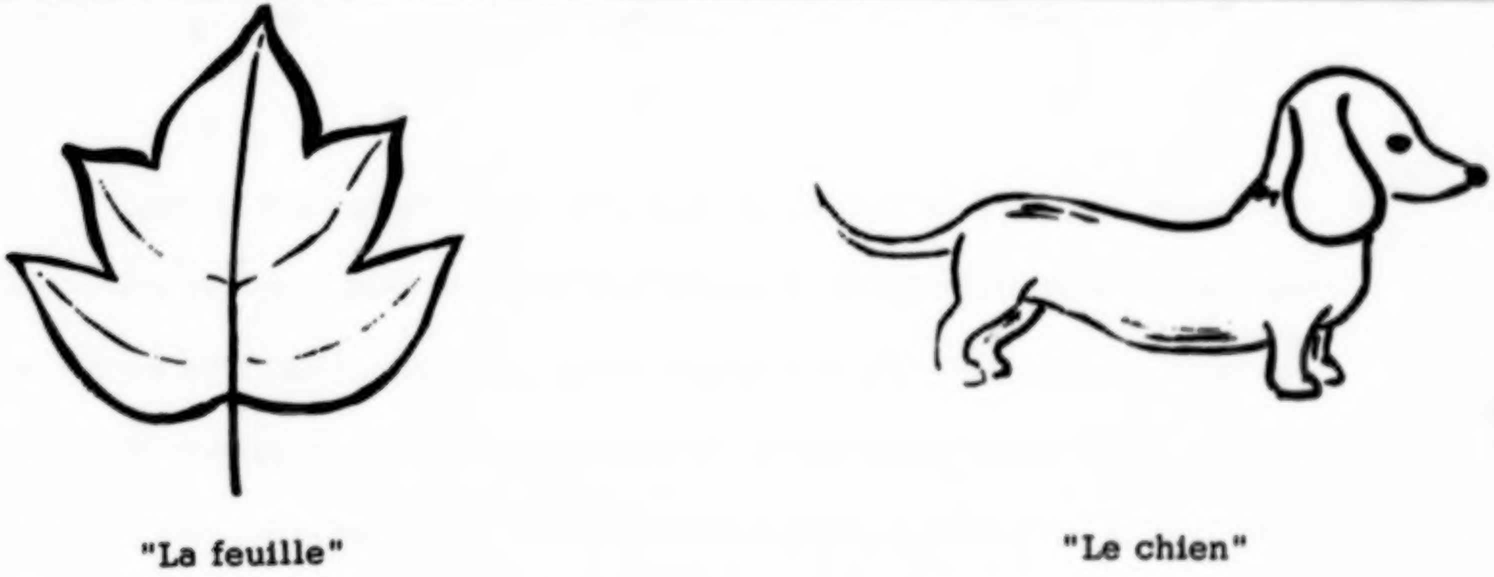
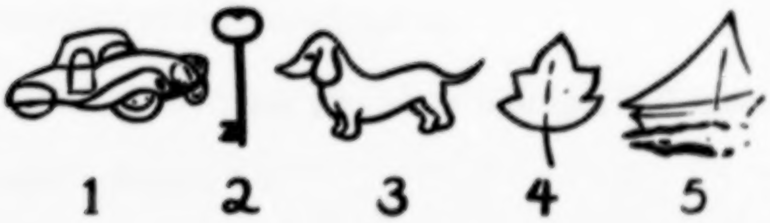
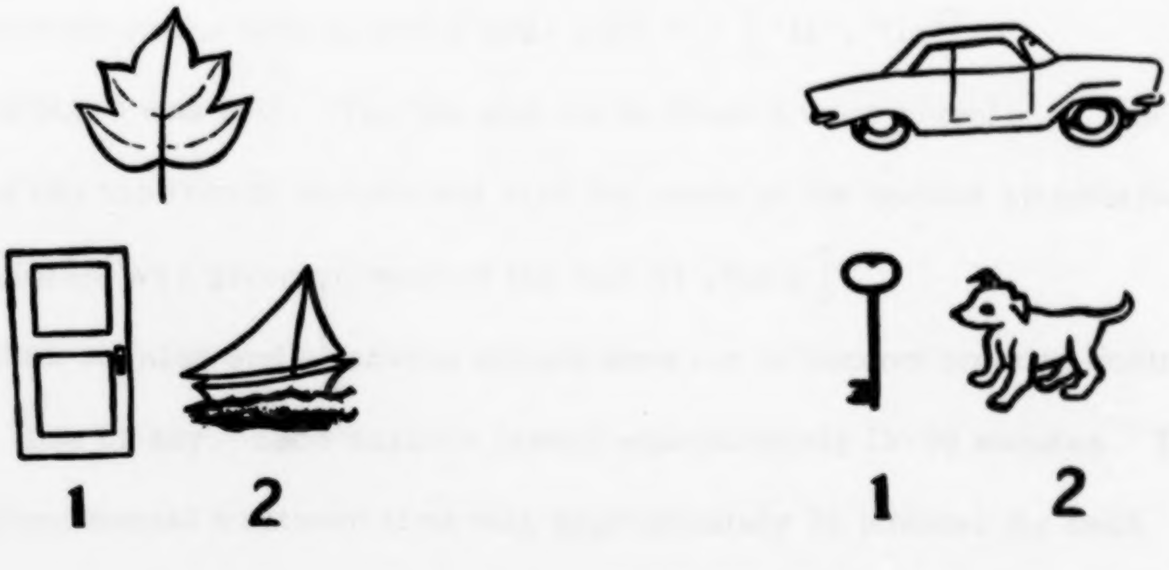
[1] See Figure Ia; [2] See Figure Ib; [3] See Figure Ic.


"La feuille"
"Le chien"

Ia. Picture-Name Association Training



Ib. Name-Picture Association Training



Ic. Experimental and Posttest Matching-to-Sample Slides

Fig. I SAMPLE SLIDES

"Look at the top picture. Now look at the bottom picture. Which of the bottom pictures goes with the top picture? If you think that picture number 1 goes with the top picture, press button 1; if you think picture number 2 goes with the top picture, press button 2. If you get a green light, you are right. If you get a red light, press the red light button and try again. Go ahead -- press a button, do it now."

The four experimental groups each received one of the following instructions for the first three of the 54 slides of the training material. For each of the remaining 51 slides, the brief verbal cue mentioned below in brackets was presented to each respective treatment group.

Group 1 was told, "Something you have learned will help you find the right answer." ["Press a button"]

Group 2 was told, "Remember the article. The article will help you find the right answer." ["Article"]

Group 3 was told, "The top picture is a 'la' ('le') word. Find a 'la' ('le') picture on the bottom which goes with it." ["la", "le"]

Group 4 was told, "The top picture is (French word given)." [The name of the top French picture and also the name of the correct alternative lower picture was given on each of the last 51 slides.]

Both morning and afternoon groups were run in random order to control for the time of day. Each session lasted approximately 15-20 minutes. The total experimental treatment time was approximately 35 minutes for each treatment group.

The problem-solving and transfer tests over the material taught in the experimental treatments were then given. Three weeks later, the children were given a brief review, retention test, and another transfer test. See Table 1.

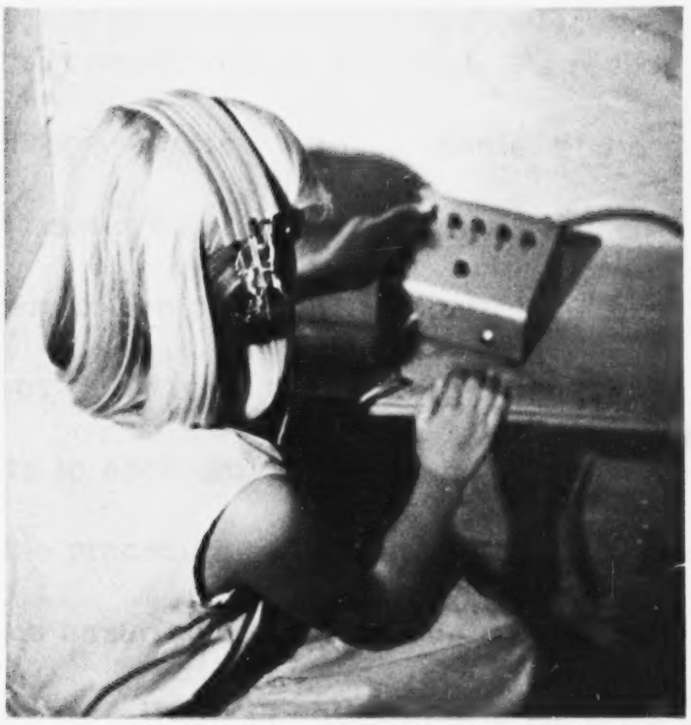
The slides in the experimental training used only combinations of three pictures from half of the 12 pictures which the children had learned to name in the preliminary training. Three of these pictures had masculine and three had feminine names. The remaining one-half of the pictures (three masculine and three feminine) were used only to form the transfer tests mentioned above. S had never seen these pictures in the experimental treatments. He had learned only the names of these pictures in the pre-experimental training sessions described above. No verbal cues were given by E on any of the tests. The problem-solving and retention tests presented new permutations of the pictures used during the problem-solving sessions. The transfer tests used only pictures which S had learned to name in French but which had never appeared during the problem-solving sessions.

Apparatus

To provide control over the experimental treatments and yet have a situation which is highly similar to a classroom, the following equipment was constructed and used. Each child, seated in an enclosed booth, viewed slides projected on the screen at the front of the room and heard E speak through earphones. The child responded to the pictures and questions by pressing buttons in a multiple-choice panel in his booth.[1] Red and green lights on his panel gave him immediate knowledge of results for his answers to multiple-choice questions. Each S was required to clear a wrong answer and try again until he was correct.

At the control center in the rear of the room, a visual display showed the correct answer and the responses made by each child to the question just

[1] See Figure II.



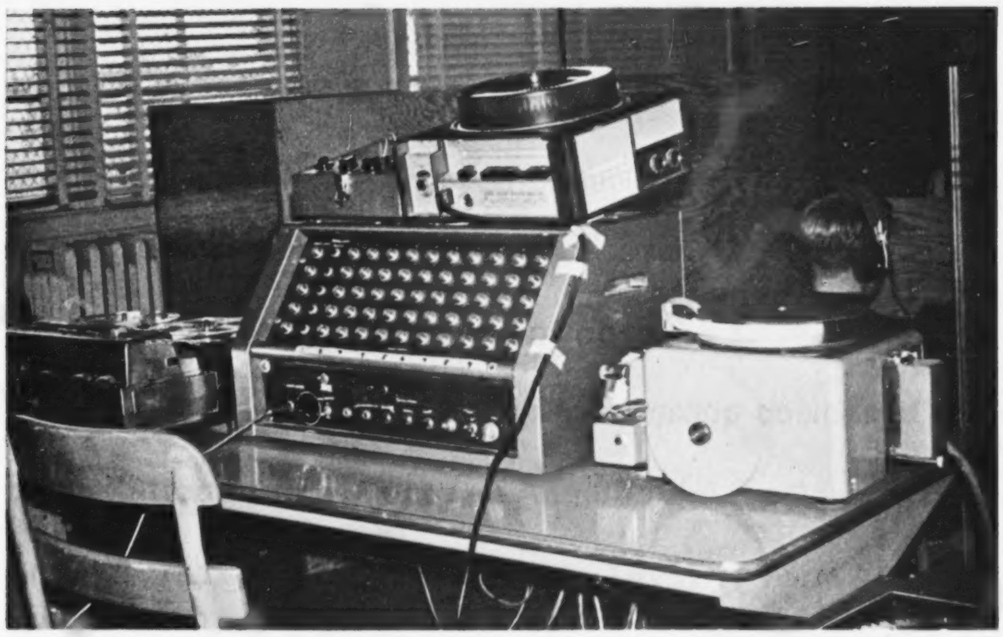


Fig. II. The Apparatus

asked. Before the sequence continued, the display was automatically photographed to record the correct answer and each _S_'s response for later keypunching and computer analysis. A tape recorder and a specially developed slide projector and master control mechanism were used to present automatically all verbal commentary to the children, to control the exposure of the 35 mm. slides on the screen, to activate the recording camera, and to supply immediate knowledge of results to each child. Once the equipment was put into operation for a session, all the procedures were automatically carried out in sequence by the machine, thus assuring fairly rigorous control over the stimuli presented to each treatment group. Up to 10 children at a time were taught or tested.[1]

Subjects

There were 52 kindergarten children in the experiment. These were the children who successfully completed the preliminary training and were then randomly assigned to the treatment groups.

There were 38 additional children who began but did not complete the preliminary training, 34 of them because of absence and 4 because of failure to pass the preliminary training test. The total group composed the entire kindergarten population of one West Los Angeles Public School.

The Lorge-Thorndike Intelligence Test, Level 1, Form A, Primary Battery, was administered to each child. Table 1 presents the means and standard deviations for IQ, MA, and CA of the treatment groups.

[1] See Figure III.

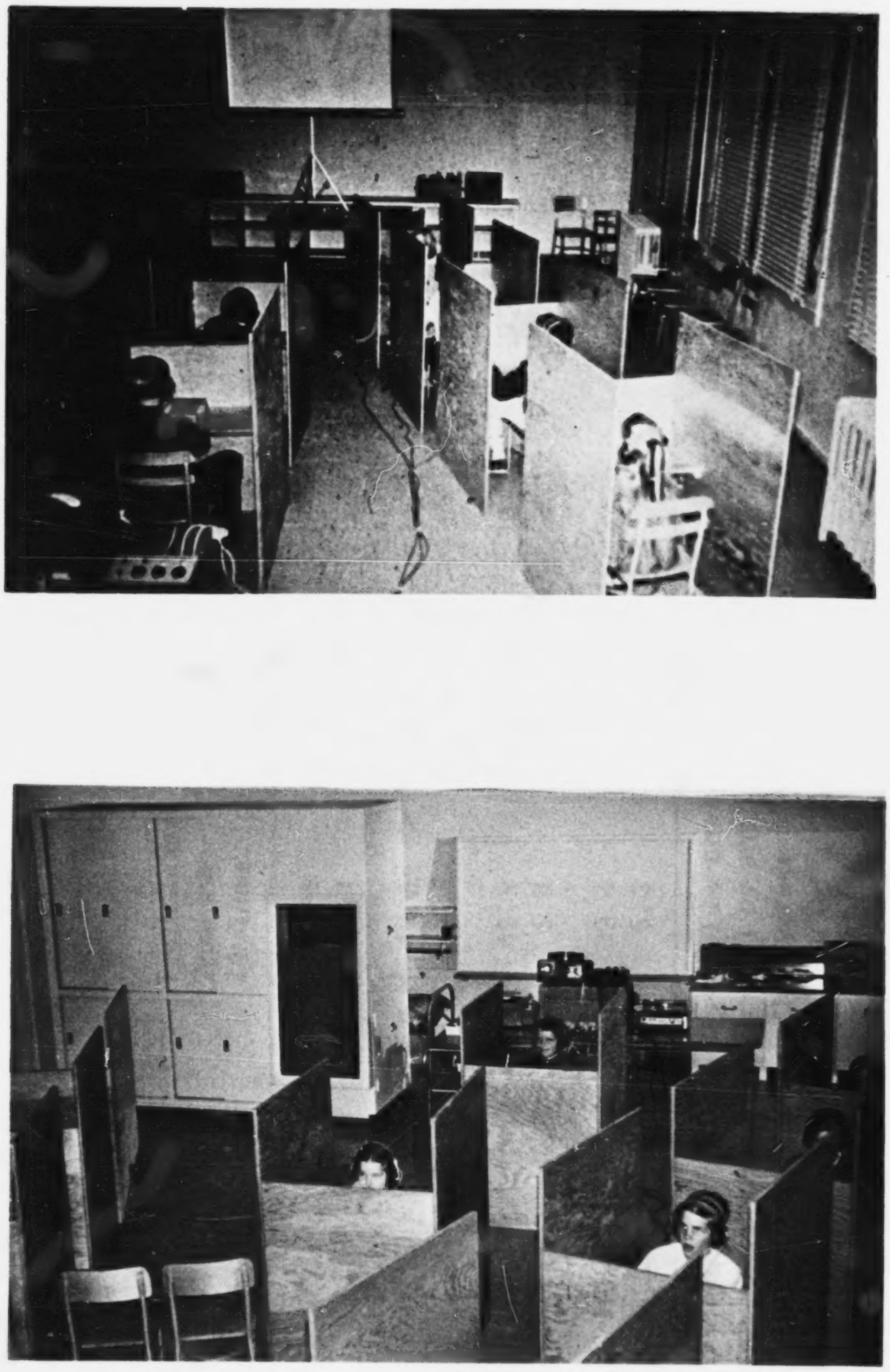


Fig. III. The Experimental Classroom

Table 1

Means and Standard Deviations

of the Treatment Group Scores

Treatment Groups	Preliminary Scores					Posttest Scores			
						Immediate		3 weeks later	
	N 39	IQ	MA	CA	Preliminary Training 48 items	Problem-solving* 30 items	Transfer** 42 items	Retention** 24 items	Transfer 24 items **
Press a Button	10	103.0	69.5	65.4	39.4	17.8	24.4	15.9	14.5
		7.6	8.5	3.5	4.3	5.1	5.7	5.0	4.0
Article (General Cue)	11	103.2	69.3	64.2	42.5	19.8	24.9	14.0	12.8
		13.2	12.0	3.8	4.9	5.2	6.5	4.5	5.6
La (Le) (Class Cue)	9	107.9	73.3	64.1	42.9	24.1***	33.7***	19.1***	18.7***
		11.4	14.2	4.1	5.8	3.7	4.0	3.4	4.0
French Name (Specific Cue)	9	112.0	76.8	65.6	39.4	19.1	23.0	12.1	11.7
		15.5	11.3	4.7	5.3	4.9	3.8	3.1	3.1

*Differences among the means significant ($p<.05$) by analysis of variance.

**Differences among the means significant ($p<.01$) by analysis of variance.

***By specific comparison test, greater than the average of the other three means ($p<.01$).

RESULTS

The data were analyzed from all children who were present for all posttests and who had correct at least 30 of the 48 items on the test of preliminary training. See Table 1. Thirteen children were absent for the retention and delayed transfer tests. They had been transferred to several different school districts. This left 39 of the original 52 children assigned to the treatment groups.

To test for homogeneity of variance, F-tests were performed for each of the four dependent variables in Table 2. None of the F-tests was statistically significant (p>.01).

Table 2

Summary of the Analyses of Variance

for the Posttests

	Immediate Tests				3 Weeks Later Tests			
	Problem-Solving		Transfer		Retention		Transfer	
	Treatment	Within	Treatment	Within	Treatment	Within	Treatment	Within
df	3	35	3	35	3	35	3	35
MS	69.1	22.9	214.6	27.6	81.4	17.1	86.2	18.6
F	3.01*		7.78**		4.76**		4.63**	

* = p<.05
** = p<.01

From Tables 1 and 2, the variance among the treatment groups' means on the problem-solving test was statistically significant, (p<.05) by analysis of variance. An analysis of covariance, with MA and preliminary training as covariables, was not significant (p>.05) which indicated that the differences among the means on the problem-solving test were due to chance. Contrary to the hypothesis about initial learning, the specific cue (French name) did not produce the highest mean score on the problem-solving test. The reason for this is not known. Because the test presented new items, rather than items identical to those used in problem-solving, transfer may have been measured. Also, the specific cues added relatively no information to the immediate feedback from the red and green lights given to all groups.

The results are in close agreement with the hypothesis about retention and transfer. For the retention test, the analysis of variance was statistically significant ($\underline{p}<.01$), and so was the specifics comparison test ($\underline{t}=3.25$, $\underline{p}<.01$) which compared the class cue group with the other three group means combined and which was computed according to the procedure in Edwards (1960, pp. 140-148). The analysis of variance was statistically significant on the immediate transfer test ($\underline{p}<.01$) and on the delayed transfer test ($\underline{p}<.01$). See Table 2. The specific comparisons test between the class cue group and the other three groups combined was statistically significant on the immediate test ($\underline{t}=4.79$, $\underline{p}<.01$) and also on the delayed test ($\underline{t}=3.46$, $\underline{p}<.01$).

As a further precaution, an analysis of covariance with MA and preliminary training as covariables was performed on the immediate transfer, retention, and delayed transfer tests mentioned above. The $\underline{F}$ ratios were statistically significant for the immediate transfer ($\underline{p}<.01$), retention ($\underline{p}<.01$), and delayed transfer ($\underline{p}<.05$) tests. These results support the hypothesis about retention and transfer and indicate that the differences among the treatment group means were not due to chance differences in preliminary training or in MA.

DISCUSSION

As hypothesized, relevant class cues, "la" or "le", rather than specific answers, e.g., "la maison", or a general cue, "article", helped kindergarten children retain and transfer to other problems involving matching on the basis of the gender of the newly learned French names. After the necessary preliminary associations were learned, transfer to new instances of the same concept was facilitated by explicit verbalization by E of the relevant class cue, followed by practice and reinforcement for applying this term.

Because the Ss were given the preliminary associations and were also taught the common response "la" or "le", why was additional verbal cueing by E important for transfer? After the preliminary associations were learned, the task for S was one of concept identification rather than of concept formation. The pictures presented on the learning and transfer tests were of ordinary stimuli which contained many possible attributes. From among these attributes only one was the correct one. It has been shown by Osler and Trautman (1961) that for many children the use of ordinary objects as stimuli presents a complex concept-attainment task, because there are many different and possible responses. Young children probably have not learned systematic ways to eliminate incorrect responses.

Learning by discovery implies that a teacher gives general cues or specific answers, but until students have "discovered" does not give explanations, distinguishing characteristics of classes, or class cues. The present study demonstrates that kindergarten children may not learn and transfer when they are left to discover and are given only general or very specific cues. They probably have to learn or must be taught systematic ways to discover and to eliminate many incorrect responses. From this study, it seems that an initial part of the process of teaching them to discover is to teach them to use class cues which have been associated with the correct answers. Even this simple step may be most difficult to teach. To develop a cue which can serve as a class cue may involve, as it did in this experiment, several months of teaching and testing.

This study indicates that whether or not discovery learning is effective probably depends upon the learner's history of associations to the problems and cues as well as upon his learned ways of discovery. The fundamental problem for future research is not whether discovery learning is or isn't as effective as some other way to learn which probably depends on what he has learned to do. The fundamental problem is to find ways to develop in children systematic methods to generate possible answers and to eliminate the incorrect ones. The important finding of this study is that their ability to do these things seems to be related to the types of cues and problems they have been presented with in the past. The mediational effectiveness of a class cue depends, among other things, upon its previous associations and on the type of test used to measure its effects.

CHAPTER VI. PILOT STUDIES FOR THE SECOND EXPERIMENT: VERBAL CUES IN THE IDENTIFICATION OF MATHEMATICAL CONCEPTS

No. 6 Testing a Program for Teaching Mathematical Concepts to Kindergarten Children.

No. 7 Effect of Different Verbal Instructions and Arrangements of Materials in the Identification of Mathematical Concepts.

No. 8 Effect of Different Verbal Instructions in the Identification of Mathematical Concepts. A Replication Study.

PILOT STUDY NO. 6

Testing a Program for Teaching Mathematical Concepts to Kindergarten Children

PROBLEM

In the experiment for Phase I of the project, a disproportionate amount of time (12 weeks) had been devoted to building in the requisite associations. Even then, some subjects had to be dropped for failure to reach the necessary criterion. After the extensive preliminary training, only two days were spent in the experimental treatments. The effects of the different verbal instructions were demonstrated and it was felt that the application to subject matter areas would be warranted. However, it was decided that more could be learned about these effects if the experimental, rather than the pre-experimental, training continued over a more extensive period of time.

For this reason, concepts with which most kindergarten children in our culture could be expected to be equally familiar were selected. These included size, shape, number, and color. The questions this pilot study attempted to answer included: (a) Were kindergarten children familiar with these concepts and the instances selected? (b) Could such children solve problems involving instances of these concepts, with and without verbal help? (c) Could they then solve problems involving 1) new instances of these same concepts and 2) different, non-verbal concepts?

METHOD

Subjects. All the kindergarten children in two classes at the UCLA training school were used. The mean C.A. in months was 66.5, with ages ranging from 57 months to 75 months. About half the children had been selected at random for Binet testing. The mean I.Q. of the tested group was 115.3,and the M.A. in months was 78.0. There were 21 boys and 21 girls. (See Table 1 for distribution of C.A. and I.Q. over treatment groups.)

Materials. Six books or sets of training materials were used. The designs were drawn on colored ditto masters, duplicated and cut out so that they could be arranged for the various sequences. The concepts used were color (red, green, purple, black); shape (circle, star, diamond, bean); number (1, 2, 3); and size (large and small). The stimulus items (frames) consisted of 8 1/2 " by 11" sheets of white paper on which three designs were arranged so that one design, the model, was in the top center of the page and two designs, the choice alternatives, were on either side of the bottom. The cutout designs were pasted on the page, which was then placed under a plastic protector. All the stimulus items of a particular set were placed in a loose-leaf binder and presented to each child individually by an examiner.

Procedure. On the first day 30 randomly selected children were asked to identify the visual stimulus when a specific verbal label was given. There were two colors (green and red), two shapes (circle and star), and two numbers (1 and 2). In the first 16 items the incorrect alternative was like the model in all dimensions except the critical one; the correct alternative was like the model in all dimensions. The instructions were: "Find the picture which is the same color (or shape or number) as the top picture." All 16 frames of this type were given to all children. The second type of item had both alternatives like the model in one dimension and one like the model in a second, the other like the model in a third. For example, with all pictures the same color, one alternative would be the same shape but a different number of designs; the other alternative would be a different shape but the same number of designs. If the critical dimension was shape, the first alternative would be correct; if it were number, the second would be correct. The order of presentation of the concepts was randomized over all the children. The second series was terminated after five successive correct choices had been made.

Book II consisted of the same type of designs but all the items were of the second type described above; that is, in each frame all stimuli were the same in one dimension and varied in two dimensions. There were 16 frames for each concept. The instructions were to match the top picture with one of the bottom pictures in (a) "color or number" (color correct); (b) "shape or color" (shape correct); and (c) "number or shape" (number correct). Again, the order of presentation of the concepts was randomized over the children. Whereas the task in the first session was merely to respond to a verbal label, the task in the second session was a hypothesis-testing one in which the child was required to determine the correct concept for each of three problems by eliminating the incorrect one. The third session, Book III, involved testing alternative hypotheses when all three could be correct. The concept labels were not given. The child was told to match the top picture in some way. Thirty frames of each of three concepts were given. After 10 correct responses the child was told: "Now we are going to try to match the top picture in a different way." Confirmation was given after each response and the correct answer indicated. The position of the correct response as well as the order of presentation of the concepts was randomized.

Two new instances of color (purple and black) and shape (diamond and bean) and one of number (3) were used in the fourth session, Book IV. There were 30 frames of each concept arranged in the following orders: H-heterogeneous--a random order of one, two, and three dimension different pictures; A-order--10 frames of one-dimension different, 10 frames of two-dimension different, and 10 frames of mixed stimuli; B-order--10 frames of two-dimension different, 10 mixed frames, 10 one-dimension different; C-order--10 mixed frames, 10 one-dimension then 10 two-dimension different pictures. The instructions were the same as for Book III. The child was required to verbalize the concept label as well as select the matching picture.

The experimental training and transfer test involved a fourth dimension, size. The colors, shapes, and numbers were the same as those used in the training sessions, but the new designs were either larger or smaller than the original ones. Two of the original 30 children having dropped out due to absenteeism, the remaining 28 trained children were randomly assigned to four treatment groups of seven each. There were 12 more children who had not been given the training described above. These children were used as a control group.

Treatment Group I was a No-Help group. These children were told:

> "Look at the top picture. Now look at the pictures on the bottom. Which of these pictures goes with this top picture? Choose one of them, and I'll tell you if you are right."

If the child chose the correct picture he was told:

> "Yes, this picture goes with the top picture."

If the child chose the incorrect picture he was told:

> "This picture goes with the top picture. Look at it. See how it goes with the top picture? Now let's look at the next page."

Treatment Group II was a General Cue group. These children were told to find the picture which was the same size as the top picture. Confirmation when correct and the correct answer when incorrect was given with each frame.

Treatment Group III was a General and Class Cue group. The children in this group were told:

> "Look at the size of the top picture. Find the bottom picture which is small (or large) like the top picture."

Treatment Group III, the Specific Cue group, was shown the correct picture by pointing, without any information as to why it was the correct one. The children were told:

> "Look at the top picture. Now look at the bottom pictures. This (pointing) picture goes with the top picture."

All treatments continued for 20 frames. This was followed by an immediate test of learning consisting of 10 frames given without instructions or confirmation.

The last session, Book VI, was a transfer to new concepts test. The materials were simple black-and-white line drawings of triangles. The four concepts were: interior design (vertical lines, horizontal lines, dots, or blank); position of bar (at point or at base); direction of point (up, down, right, or left); and type of frame (dotted round, solid round, dotted square, solid square). Thirty items were administered to all children without instruction; the last 10 items were scored.

The children of the Control group were given the materials of Books I, II, and III without any instruction. They were simply told they had selected the correct or incorrect picture. The experience was very frustrating and only five of the children were willing to return for Book IV.

RESULTS

The scores made by the treatment groups and the control group on the training, experimental treatment posttest, and the transfer to new concepts test are given in Table 1.

TABLE 1

C.A., I.Q. and Scores of Experimental Treatment Groups

Training and Transfer

		GROUP I (No Help)	GROUP II (General Cue)	GROUP III (General & Class Cue)	GROUP IV (Specific Cue)	GROUP V (Control)
C.A.	M	67.1	67.3	66.7	66.3	63.8
	SD	4.4	3.8	5.2	3.6	5.4
I.Q.	M	116.5	115.6	115.5	112.5	118.3
	SD	8.5	6.6	2.7	12.7	9.0
PRE-EXPERIMENTAL TRAINING SESSIONS A, B, and C (No. of errors to criterion--90 items)						
A	M	4.1	6.9	4.1	6.7	26.7
	SD	1.9	6.7	3.6	7.1	8.2
B	M	6.9	8.9	5.6	7.1	29.4
	SD	3.8	6.2	3.1	3.4	9.3
C	M	17.4	17.6	15.0	18.9	29.0
	SD	5.2	8.9	11.5	7.7	8.7
PRE-EXPERIMENTAL TRANSFER TO NEW INSTANCES, SAME CONCEPTS (No. of errors to criterion--90 items)						
	M	9.0	9.1	6.9	6.6	14.4
	SD	6.3	7.6	4.0	5.7	9.0

EXPERIMENTAL TRAINING (NEW CONCEPT) TEST
(No. of errors--10-item test)

M	2.1	.14	.29	2.4	----
SD	1.2	0	.46	2.1	----

TRANSFER TO NEW CONCEPTS TEST
(No. of errors--10-item test)

M	3.3	2.5	4.5	3.7	----
SD	2.5	1.7	1.9	1.7	----

When the concept labels were given, the children all scored above 90% (less than seven errors out of 90) in concept identification. This was accepted as evidence that kindergarten children were familiar with these concepts. They were also able to solve problems with these concepts with over 90% accuracy (less than 1 error in 10) if some type of verbal cue was provided, and with over 70% accuracy (less than 3 errors in 10) when no helpful cue was given. Scores not significantly different from each other by treatment group, nor from chance, were made on the new concepts transfer test.

From these results it seemed that the materials and problems would be appropriate for the mathematics experiment phase of the project and a large-scale try-out with the experimental equipment was initiated.

PILOT STUDY NO. 7

Effect of Different Verbal Instructions and Arrangements of Materials in the Identification of Mathematical Concepts

PROBLEM

The materials for the mathematics phase of the project had to be converted into 35 mm. slides for projection with the Kodak Carousel Slide Projector and presented in a group situation. It was the purpose of this study to try out the materials and equipment with a large group of kindergarten children. Also, in the previous pilot study it seemed that the sequence of presentation of the slides in terms of difficulty level, i.e., whether the possible choice alternatives varied in one, two, or three dimensions on the same frame, could be quite as effective in influencing learning as were the types of verbal instructions accompanying the slides. For this reason it was decided to introduce a new variable into the design--a random vs. ordered sequence of pictorial stimuli.

METHOD

Subjects. All the children (132) in the six (three a.m. and three p.m.) classes of a large West Los Angeles elementary school were used. An experimental form of the California Test of Mental Maturity, Level O, was used to evaluate mental ability, and since no standardized norms were yet available the raw score on this test was used to rank the children for randomization into treatment groups. The raw score ranged from 15 to 48 with the exception of one subject, later excluded from the group, who made a score of 8. The mean score for the group was 29.9, with S.D. of 7.1. The C.A. and CTMM scores for this group are listed under School 1, Tables 1 and 2.

TABLE 1

C.A. In Months

Group	School 1		N	School 2		N	Total		N
	M	SD		M	SD		M	SD	
Control	67.7	3.8	13	69.3	3.0	11	68.4	3.4	24
Class Cue	67.6	3.1	12	68.0	2.7	6	67.7	2.9	18
General Cue	67.2	3.8	13	71.6	2.7	7	68.7	4.0	20
Strategy Cue (Ordered)	68.1	3.5	11	69.2	3.1	9	68.6	3.3	20
Strategy Cue (Random)	70.2	1.3	6	69.8	4.3	11	69.9	3.5	17
No Help (Ordered)	68.4	4.0	14	68.6	3.2	9	68.5	3.7	23
No Help (Random)	67.9	3.2	9	67.8	3.6	11	67.9	3.3	20

TABLE 2

CTMM Scores

Group	School 1		N	School 2		N	Total		N
	M	SD		M	SD		M	SD	
Control	29.2	5.6	13	33.1	7.5	11	31.0	6.7	24
Class Cue	30.8	8.5	12	33.7	5.3	6	31.7	7.5	18
General Cue	31.2	7.1	13	29.9	7.6	7	30.7	7.1	20
Strategy Cue (Ordered)	31.5	6.4	11	31.0	8.0	9	31.3	7.0	20
Strategy Cue (Random)	35.8	6.1	6	31.3	8.1	11	32.9	7.6	17
No Help (Ordered)	30.9	5.8	14	33.3	7.7	9	31.9	6.6	23
No Help (Random)	31.2	3.7	9	32.5	5.8	11	31.9	4.9	20

Materials. The materials tried out in Pilot Study No. 6 were adapted for use in this study. Colored construction paper was used to form the various designs and sizes of the stimuli and color slides were made of the frames or items. There were two copies of each slide, one for the randomly-arranged sequence, and one for the ordered sequence. Thus the random program and the ordered program consisted of exactly the same pictorial stimuli, with only the order of presentation varied. The verbal instructions for each treatment group were identical for both the ordered and random sequences. These instructions were recorded on magnetic tape and presented automatically over the tape recorder. For the training sequences, the concepts and instances were as follows: color (red, green, black, orange); number (1, 2, 3, 4); size (large, small); shape (circle, star, diamond, bean). The transfer to new instances of the same concepts used new colors (pink, yellow, blue) and new shapes (square, crescent, egg) photographed on a black rather than a white background. The transfer to new concepts used the same type of materials as in Pilot Study No. 6, i.e., the triangle with bar and frame, but only two instances of each concept were used. (Interior design--lines or blank; position of bar--point or base; direction of point--up or down; and type of frame--square dotted or square solid.)

Apparatus. In this study the same equipment was used as for the experiment in Phase I. There were 10 three-sided booths, each with an individual response panel, and set of head-phones. (The microphones were not used in this experiment.) Magnetic tape played over a Wollensak tape recorder (a) controlled the presentation of the slides from a Kodak Carousel Slide Projector, (b) determined the exposure and response time for each item, and (c) delivered the same verbal instructions to each child. A master control panel registered the responses of each child, which were recorded by a 16 mm. stop-frame camera positioned behind the panel. Each child received confirmation and feedback by a green or red light on the individual subject panel.

Procedure. All the children were given the California Test of Mental Maturity, Level O, before being introduced to the machine set-up. After this, four days of familiarization training were provided. The children were taught to put on and take off the headphones and to respond to the experimental task of pressing a button to indicate the position of the choice alternative selected, whether on the left or the right. On the fifth day a sequence of 48 slides simulating the experimental matching task, but using pictures of animals, etc., was presented.

A period of three weeks ensued over which a number of different types of slides (involving differences in color contrasts) as well as changes in tape recording techniques (stereo rather than monaural) were tried out. At the end of this period a new pre-training series was administered and the experiment proper was begun. Seven experimental treatment groups were formed.

Each of the training sessions consisted of 48 slides and took approximately 12 minutes. There were four problems, one of each concept of color, size, number, and shape, arranged in random order from one day to the next. The first two items of each problem were practice items and the next 10 items were scored to evaluate progress in learning to identify the concepts.

All children received four days of training in concept identification, with the same visual materials. However, those children in the ordered sequence groups saw the slides in the following arrangements. On the first day, both choices were exactly like the model in all dimensions except the critical one. The correct choice was exactly like the model, the incorrect one was different from the model in only that one dimension. On the second day, the correct choice was like the model in only the relevant dimension and unlike the model in all other dimensions. The incorrect choice was like the model in all the irrelevant dimensions, but unlike the model in the critical dimension. On the third day the correct choice was like the model in two dimensions, one of which was the critical one; the incorrect choice was like the model in one dimension and like the other alternative in another dimension. Both the correct and the incorrect choice differed from the model and from each other in the two other irrelevant dimensions. The fourth day presented items in which the correct choice was like the model in two dimensions (one of which was the critical one) and the incorrect choice was like the model in two dimensions (neither of which was like the critical one).

Copies of all the 192 slides used in the above sequences were mixed together and four sets of 48 selected at random to make up the four random order sequences.

These materials were presented under four different treatment (verbal cueing) conditions. The Specific Cue group was shown only the random sequences. With each slide they were told to match the approximate instance for that particular problem. For example, in the color problem they were told: "The picture on top is red. Find a red picture on the bottom to go with it." The Class Cue group was also shown only the random sequence of slides and were told: "Look at the color of the top picture. Find a bottom picture of the same color to go with it."

There were two General Cue and two No Help groups, one of each receiving the ordered sequence of slides, the other the random sequence of slides, but with the same verbal instructions for that treatment. The instructions for the Strategy Cue group, regardless of the slide sequence used, were: "We are going to learn to choose a bottom picture to go with the top picture. One of the two bottom pictures goes with the top picture according to a certain rule. Here's what we mean by a rule. Look at the top picture. It is a circle. The rule is to find a bottom picture of the same shape to go with it. The rule is shape."

Five of the items in the sequence were cued, the other five were given feedback but no cue. For the remaining three problems of the first session they were merely told to match the top picture according to a different rule. On the first problem of each of the subsequent sessions the appropriate "rule" was given (color and size). For the first problem of the fourth session they were told to find a rule for matching the top picture, but the concept label (number) was not given.

The instructions for the No Help group were to select a bottom picture to go with the top picture. If a green light came on, the correct picture had been selected; if a red light, the instruction was to press the button for the other picture.

The Control group was given equal opportunity to perform on the machines. However, the pictures and task were quite different. This group was shown black-and-white slides with representational pictures. The task was to match the initial sound of the model picture. For instance, if the model showed a dog, and the choices a door and a house, the correct choice was the picture of the door. The Control group received the same number of items and the same general procedure, except that the material used was different.

On the fifth day all the children, including the Control group, received the same slides for the learning test, with the same set of verbal instructions. The slides were randomly selected and sequenced, and contained some instances of the four levels of difficulty. The verbal instructions were simply to match the top picture.

The sixth and seventh sessions involved transfer, first to new instances of two of the same concepts (color: yellow, pink, blue; shape: egg, square, crescent), and then to new concepts (the triangles). In both of these transfer tests half the problems consisted of items arranged in random sequence and half in ordered sequence. The last 12 items of the last session comprised a concept identification (discovery) test. Three items of each of the concepts of size, number, shape, and color were presented at random and the task was to select the alternative which was like the model according to the concept label given. Those children who did not make at least 9 correct choices out of 12 were judged as insufficiently familiar with the basic concepts and were not included in the final analyses. The results of the learning and transfer tests are summarized under School 1 in Table 3. In these tables the N reflects the fact that 37 subjects were dropped because of incomplete data, and 17 because of inability to handle the concepts.

TABLE 3

Means and Standard Deviations for the Dependent Variables

Group		LEARNING TEST			TRANSFER TO NEW INSTANCES			TRANSFER TO NEW CONCEPTS		
		School 1	School 2	Total	School 1	School 2	Total	School 1	School 2	Total
Control	M	28.4	27.6	27.8	29.4	38.0	33.5	35.0	38.7	36.7
	SD	8.9	4.6	6.0	10.4	9.0	10.5	8.8	8.1	8.5
	N	5	11	16	12	11	23	13	11	24
Specific Cue	M	38.8	26.5	32.1	41.8	34.6	39.7	39.3	33.7	37.4
	SD	5.7	7.0	8.9	10.7	11.8	11.2	7.1	11.9	9.0
	N	5	6	11	12	5	17	12	6	18
Class Cue	M	31.2	31.4	31.3	44.4	42.5	43.8	35.4	46.1	39.2
	SD	6.5	9.5	8.1	10.8	8.7	10.0	7.1	1.4	7.8
	N	5	7	12	12	6	18	13	7	20
General Cue (Ordered)	M	18.4	25.1	21.6	34.5	41.6	37.5	39.0	39.8	39.4
	SD	8.4	5.1	7.7	9.8	5.9	8.9	6.8	10.5	8.4
	N	10	9	19	11	8	19	11	9	20
General Cue (Random)	M	29.5	26.5	27.5	46.4	39.8	41.9	39.8	39.4	39.5
	SD	8.9	3.6	5.9	12.5	10.6	11.2	10.5	7.7	8.4
	N	6	11	17	5	11	16	6	11	17
No Help (Ordered)	M	20.7	28.8	25.3	39.1	42.6	40.9	35.9	41.2	38.0
	SD	4.0	8.5	7.9	7.4	9.3	8.3	8.1	7.4	8.1
	N	7	9	16	8	8	16	14	9	23
No Help (Random)	M	22.6	25.0	24.1	33.2	38.9	36.4	39.9	39.2	39.6
	SD	2.1	4.7	4.0	4.4	6.2	6.1	8.7	5.2	7.4
	N	8	11	19	9	11	20	9	5	14

RESULTS AND DISCUSSION

As can be seen in Table 3, the arrangement of the visual stimuli (whether ordered or random) did not seem to have any facilitating effect on learning. The No Help group, whether the materials were ordered or random, did most poorly as a whole. The experience of the Control group with the sound-matching task seemed to be more effective in producing learning with the mathematics materials than did practice-without-instruction with the identical materials.

The ordered-stimuli groups and the Control group were not included in the analysis of variance. The results of the four treatment groups (General Cue, Class Cue, Specific Cue, and No Help) in the learning test as well as in the transfer-to-new-instances of the same concepts and transfer-to-new-concepts test are shown in Table 4.

TABLE 4

Summary of Analysis of Variance

(Four Treatment Groups on Measures of Learning and Transfer)

	Learning Test		Transfer	New Instances	Transfer	New Concepts
	School 1	School 2	School 1	School 2	School 1	School 2
df	3, 19	3, 31	3, 34	3, 29	3, 36	3, 25
MS_w	38.1	36.5	98.1	190.3	64.2	56.7
MS_b	260.4	62.0	278.6	1355.3	53.3	170.4
F-ratio	6.8**	1.7	2.8	7.1**	0.8	3.0*

*$p < .05$

**$p < .01$

The Class Cue group was significantly better ($p > .01$) than the next best group, the General Cue group, on the immediate learning test. The results on the tests of transfer of discovery ability showed no clear-cut trends. These results might have been influenced by the fact that the children had been exposed to many pre-experimental sessions in which various types of materials were tried out, and because equipment and mechanical problems had interrupted the smooth presentation of some of the final sessions.

It was decided to continue with the original design, i.e., to gather more data with a similar school population to augment the number of subjects in each of the treatment cells. This was necessary because the number of treatment groups (seven) made it impossible to find any one school with a large population to furnish a sufficient sample.

PILOT STUDY NO. 8

Effect of Different Verbal Instructions and Arrangement of Materials in the Identification of Mathematical Concepts. A Replication Study

PROBLEM

The present study was a replication of Pilot Study No. 7. Its purpose was to provide additional cases for the various treatment cells. Because of the large number of treatments (seven) the number of subjects available per cell was too small for differences to be statistically significant. For this reason it had been planned to replicate the study at another school with a similar student population. Since the two schools used drew upon a similar socio-economic group, and the distribution of C.A. and CTMM scores were also alike, it was felt that this assumption was justified.

METHOD

Subjects. All the children (94) in four (two a.m. and two p.m.) classes of a large West Los Angeles elementary school were used. An experimental form of the California Test of Mental Maturity, Level O, was used to evaluate mental ability. Since no standardized norms were yet available, the raw score was used to rank the children for randomization into treatment groups. The raw score ranged from 16 to 45. The mean score for the group was 30.6, with S.D. of 7.1. This compared with a mean of 29.9 and S.D. of 7.1 for School 1, Pilot Study No. 7. The C.A. and CTMM scores for this group are listed under School 2, Tables 1 and 2, respectively.

Materials and Apparatus. Exactly the same materials, instructions, and apparatus were used in Schools 1 and 2. These are described in Pilot Study No. 7.

Procedure. The same general procedure was followed as in Pilot Study No. 7. The only difference was that three days of experimental training were provided, rather than four. The first session consisted of half of the slides from the previous first session, and half from the second session, selected at random. Other than this exception, the treatment groups and instructions replicated as closely as possible the preceding study

RESULTS

In the replication study, 24 children were below criterion in concept identification. Fifteen more children were dropped because of incomplete data due to absences. The scores on the learning and transfer tests for the remaining 55 subjects are given under School 2 in Table 3, Pilot Study No. 7. Again, no significant differences in learning could be attributed to whether the material was presented in accordance with level of difficulty of the items, or simply at random. Contrary to the results at School 1, no differences in learning could be attributed to differences in verbal instructions at School 2 (see Table 4, Pilot Study No. 7). The results of the transfer tests at School 2 showed significant differences ($\underline{p}<.01$) for transfer to new instances of the same concepts and ($\underline{p}<.05$) for transfer to new concepts. However, the results from School 1 and School 2 were so different that no analysis of variance was computed for the combined scores. An inspection of the combined mean scores themselves (see Table 3, Pilot Study No. 7) indicates that most of the mean differences between treatment groups are not statistically significant.

CONCLUSIONS

The analysis of the results of School 1 and School 2 both individually and as a total group demonstrated differences in scores so close to chance that no statistically significant differences could be attributed to either the arrangement of the pictorial stimuli, or verbal instructions. It was felt that the meaningfulness of the concepts was not strongly enough established with kindergarten children to permit easy concept identification, and problem-solving with these concepts. In addition, it was felt that a clearer statement of the verbal instructions was necessary, especially with the General Cue group, to establish verbal cues controlling wider classes of responses. As a result of Pilot Studies 7 and 8 it was decided to prepare new tapes with more precise verbal cues and carry out the experiment for the first part of Phase II with older children.

CHAPTER VII. THE SECOND EXPERIMENT: VERBAL CUES IN THE IDENTIFICATION OF MATHEMATICAL CONCEPTS

PROBLEM

In the experiment for Phase I, the effects of the verbal cues were demonstrated with material which was abstract and unfamiliar to kindergarten children. It was found that the class cue produced substantial ability to discover. More specifically, on tests where a child was given problems which he had never faced before, but was given no verbal cues from a teacher, he was able to discover in what way a top picture was like a bottom picture. Although children of all treatment groups had previously learned to associate French names with appropriate pictures, to discriminate "la" nouns from "le" nouns, and to recognize that "la" and "le" were both articles, only the children of the Class Cue group were able to discover that ordinary objects might be grouped together on the basis of the gender of their French names. In brief, Experiment 1 found one effective way to teach children to discover certain relationships. Neither the "specific" cue nor the "general" cue was effective for teaching how to discover relationships. These relationships were as predicted in Chapter III. However, the test used to measure the children's increased ability to discover relationships included only items on the masculine and feminine genders of French names.

In the experiment below, discovery of new concepts, a new dependent variable, is added to the dependent variables used in the experiment of Phase I. The experiment below was designed to find out if the results with the unfamiliar materials used in Phase I would also occur when more familiar concepts, which are taught in elementary schools, were used. The concepts of color, size, shape, and number provided the stimuli of the study, and third and fourth grade elementary school children provided the responses.

The experiment below tests the generality of the results of Phase I and, by including discovery of new concepts as a dependent variable, provides an initial test of the second part of the hypothesis of Chapter III. If there is an inverse relationship between the specificity of the verbal cue and the transfer of ability to discover, the General Cue group should produce the greatest mean on the test of discovery of new concepts.

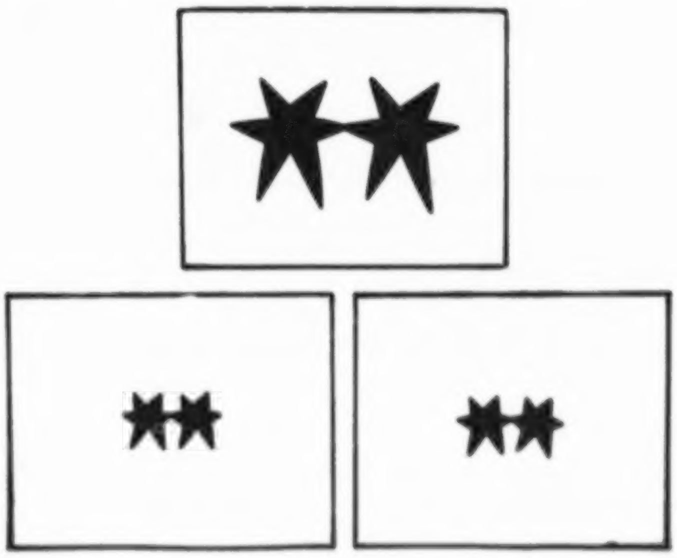
METHOD

Subjects. There were 160 children in the study. All children came from one West Los Angeles elementary school. Twenty-five of them were in the second grade and 135 were in the third grade. The mean C.A., M.A., and Kuhlman-Anderson I.Q. of each of the treatment groups are listed in Table 1.

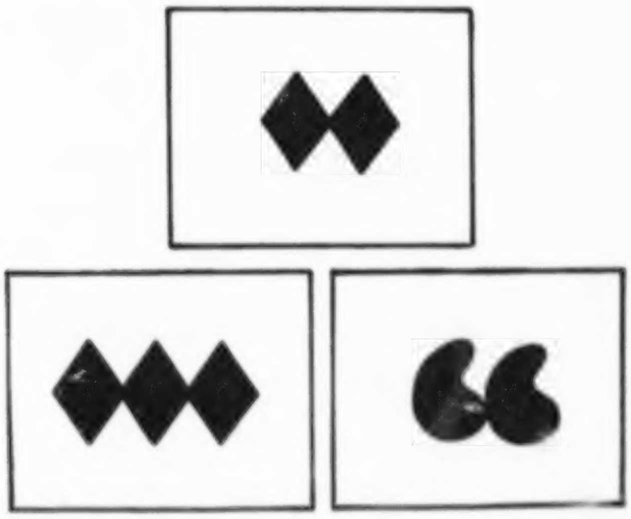
Apparatus. The major components of the apparatus consisted of 10 three-sided booths, 10 response panels, a Wollensak stereo tape recorder, a modified 35 mm. Kodak Carousel slide projector, a master-panel control center, and a Clary Account-O-Punch, paper tape data recorder. With the exception of the data recorder, the apparatus was identical to that described in the experiment for Phase I.

Materials. The stimuli were the same 35 mm. color slides used in Pilot Studies 7 and 8 (see Ch. VI). Each slide presented three pictures, one at the top and two below -- one at the lower right and the other at the lower left.[1] Each picture could vary in color, size, shape or number. Four colors (red, black, orange, and green), two sizes (large and small), four shapes (circle, diamond, star and bean) and four numbers (1, 2, 3, and 4)

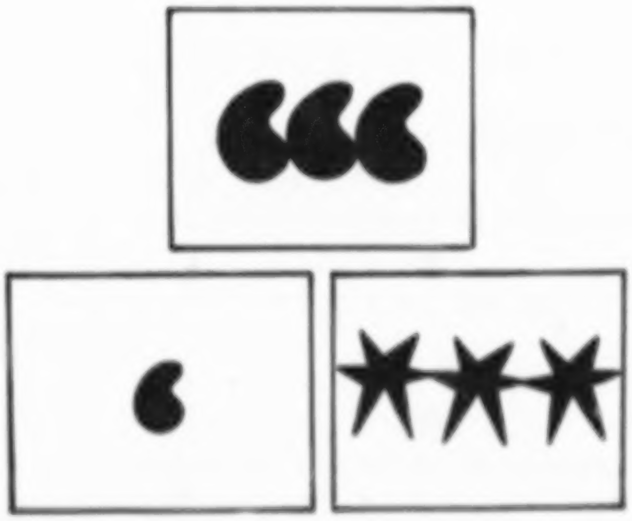
[1] See Figures Ia, b, c, and d.



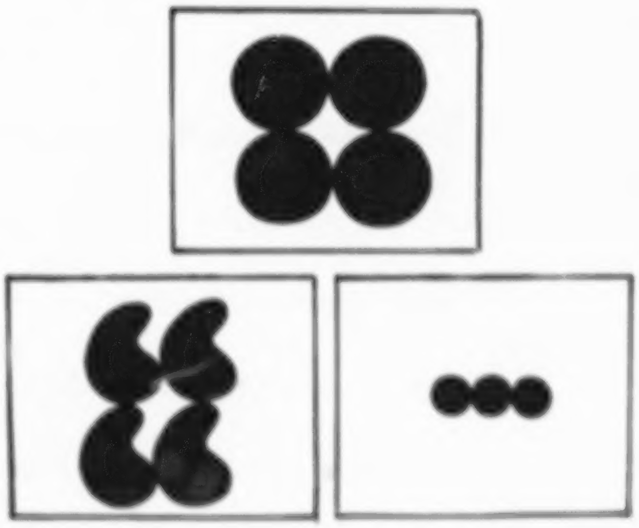
Ia. Color Only



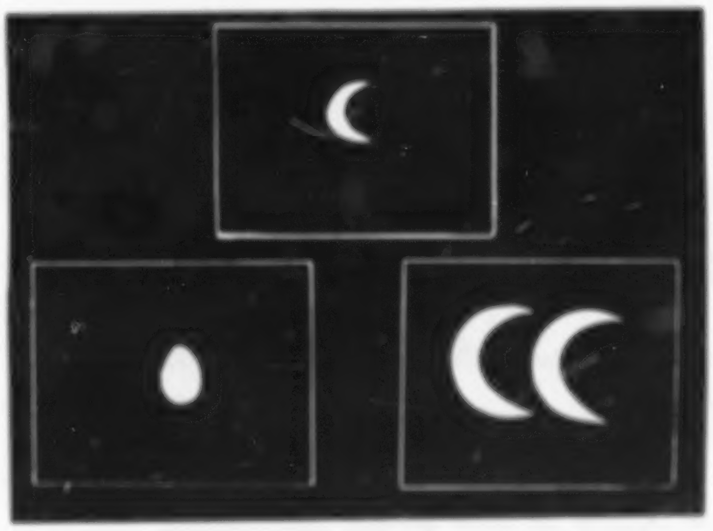
Ib. Shape vs. Number



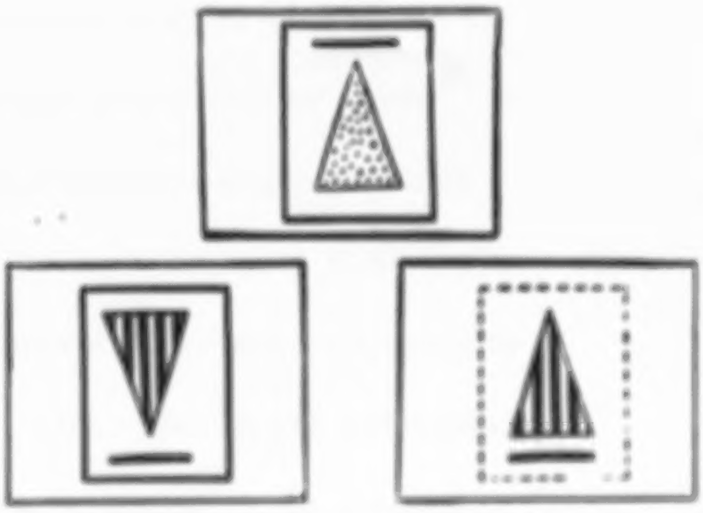
Ic. Color and Shape vs. Number and Size



Id. Number, Color and Size vs. Shape



Ie. Transfer: New Instances, Same Concepts



If. Transfer: New Concepts

Fig. I SAMPLE SLIDES

were used to form the pictures. For each slide, one of the bottom pictures was like the top picture in the critical dimension. Each problem consisted of a sequence of 10 to 15 slides where the basis for the correct choice was one of the four dimensions mentioned above. For example, in a color problem, if the top picture was green in color, the correct choice would be the lower picture which was also green in color; if the top picture was red, the correct choice would be the lower picture which was also red, regardless of size, shape, or number of designs.

The tapes presented the different experimental treatments and controlled the rate of presentation of the sound and slides. After the introductions were given, the different cues were presented simultaneously with each slide in the learning sessions. Eight seconds were allowed on each slide for the child to respond. On the tests, no cues about the right answers were given.

Procedure

Preliminary testing. Two days of preliminary testing were given to determine which children could correctly respond to the spoken words "color", "size", "shape", or "number" by matching-to-sample on these bases. Twelve items of each of these concepts were included among 106 items, 58 of which were irrelevant. The irrelevant items were matching to concepts such as "animal", "toy", "flower", etc.. The reason for including irrelevant items was to avoid calling particular attention to the concepts of color, shape, size, and number, which were to be used as the problems in the experiment. The secondary purpose of the preliminary materials was to acquaint each child with the experimental setting and with the basic experimental task of matching-to-sample by selecting one of two bottom pictures to go with a top picture.

Experimental training. The 160 children were stratified according to I.Q. and 40 were assigned at random to each of the four treatment groups. The treatment groups differed from each other only in the word or words spoken while each slide of each problem was being shown. The four groups were:

(a) The Specific Cue group. They heard the correct, specific answer on each slide of each problem, e.g., "red", "green", "blue", or "yellow".

(b) The Class Cue group. They heard with each slide the correct concept label, e.g., "color".

(c) The General Cue group. They heard with each slide "color or size or some other way".

(d) The Control group. They were given only the preliminary tests and the posttests.

Each treatment group, except the Control group, was given three days of experimental training. Each day consisted of a total of 60 items divided into six problems of 10 items. The order in which the problems were presented was: Day 1) color, shape, color, size, shape, number; Day 2) size, number, shape, number, color, size; Day 3) number, size, number, shape, size, color.

The training sequences were followed by a learning test consisting of four problems of 15 items each. All the children received the same verbal instructions, i.e., to "match the top picture". The first 10 items of each problem were considered practice items, and only the last five items of each problem were scored. This provided a possible learning score of 20.

Thirty-one children in the Specific Cue group, 26 in the Class Cue group, and 35 in the General Cue group failed to reach the criterion of four out of five for each concept, or 16 out of 20 (80%) for the total test. A fourth day of training was, therefore, given to all children.

Testing. The first 10 items of each problem of the learning test were given the treatment cue; the last five items were presented without verbal cues and were scored as test items. In this test all children in the Class Cue group reached criterion level. Six children in the Specific Cue group and 24 in the General Cue group required additional training. This was followed by another learning test administered in two parts. The first sequence of 60 items consisted of two problems (size and color) which were given appropriate treatment cues for 10 items and no cues for the last five items, and two problems which were completely uncued. The last 10 items of the two uncued problems were scored for the learning test. The second sequence of 60 items was similar to the first except that the first two (cued) problems were number and shape, and the uncued problems were color and size. The four uncued sequences combined provided a final criterion score with a maximum of 40 items.

All children were then given the transfer tests.

Transfer Test 1 involved discovery of the learned concepts, when new instances of the concepts were presented. The stimuli were different in shape and color from the training stimuli.[1] Also, the background color was black instead of white. No differential instructions and no cues were given

[1] See Figure Ie.

on any of the items. All groups, including the control group, were told only to match the top picture to one of the bottom pictures. The last 10 items of each of four problems of 15 items were scored as test items, providing a 40-item test.

Transfer Test 2 involved discovery of new concepts. Each slide consisted of a model picture and two choice pictures. These pictures showed a narrow triangle with a bar placed at the base or the tip inside a frame.[1] The problems involved matching the top picture with a bottom picture on the basis of the interior design of the triangle (lines or dots), the position of the bar (base or tip), direction of the tip (up or down), or the type of frame (dotted or solid). As in Transfer Test 1, the last 10 items of each problem were scored.

Three weeks later the following tests were administered on three successive days. One was a test over the experimental training materials. A repetition of Transfer Tests 1 and 2, with the same slides in different order, was presented. In addition, a two-problem reversal test was administered. Each session of training or testing lasted approximately 15 minutes. Children were taught in groups of 10 or less.

RESULTS AND DISCUSSION

The data from all subjects were analyzed by analyses of covariance with MA and preliminary training score as covariables. To test for homogeneity of variance an F-test (Edwards, 1960, p. 105) was performed for each of the dependent variables reported in Tables 1 and 2. None of the F-tests was statistically significant ($p > .05$). Table 1 reports the results of the analyses of covariance. The Control group was not included in the analyses of covariance because the analyses attempted to test whether there

[1] See Figure 1f.

was a significant difference among the means of the three treatment groups. It was also felt that the presence of a Control group mean might unjustifiably inflate the *F*-ratio.

TABLE 1

Summary of the Analyses of Covariance for the Experimental Groups, with MA and Preliminary Training as the Covariables and the Tests of Ability to Discover as the Dependent Variable

	Immediate Tests			3 Weeks Later Tests		
	Learning	Transfer: New Instances	Transfer New Concepts	Retention	Transfer: New Instances	Transfer: New Concepts
df	2 , 104	2, 104	2, 104	2, 104	2, 104	2, 104
MS_w	27.76	29.06	20.79	19.81	28.60	38.96
MS_b	394.45	428.48	52.08	284.49	374.91	143.54
F	14.21**	14.74**	2.51	14.36**	13.11**	3.68*

*$p<.05$
**$p<.01$

From Table 1, the learning, retention, and transfer to new instances tests show statistically significant ($p<.01$) variances among the means. The delayed transfer-to-new-concepts test was significant ($p<.05$), but a significant difference did not appear on the immediate test for this type of transfer.

Table 2 presents the means and standard deviations of the treatment groups for each dependent variable. The specific cue and class cue treatments produced a decided effect upon learning, retention, and transfer to new instances of the previously learned concepts.

TABLE 2

Means and S.D.'s of MA, CA, IQ, and the Posttest Measures of Learning, Retention, and Transfer of Ability to Discover

Treatment Group	MA	CA	IQ	Immediate			3 Weeks Later		
				Learning 40 items	Transfer to new Instances 40 items**	Transfer to new Concepts 40 items	Retention 40 items **	Transfer to New Instances 40 items**	Transfer to new Concepts* 40 items
Specific Cue N=36	107.7 10.4	99.1 3.7	108.8 11.1	32.2 5.5	34.8 5.6	32.0 3.9	36.3 3.6	36.6 4.0	30.7 6.5
Class Cue N=38	105.9 11.4	99.0 3.5	107.1 11.6	33.4 4.9	35.2 5.3	31.7 4.8	37.1 3.9	36.0 5.9	29.5 7.3
General Cue N=35	107.6 11.0	98.9 4.0	108.9 11.0	27.3 6.0	29.2 6.4	29.9 5.1	31.9 5.8	30.9 7.1	26.9 6.2
Control N=37	107.9 11.8	100.0 4.4	108.1 12.2	28.8 4.3	31.6 5.0	30.4 7.9	33.9 4.0	33.7 5.5	28.4 7.6

*$p<.05$ by analysis of covariance, MA, and preliminary training score as covariables

**$p<.01$ by analysis of covariance, MA and preliminary training score as covariables

The Specific Cue group mean and the Class Cue group mean were not statistically different from each other, but each was higher than the mean of the General Cue group on the immediate learning and transfer-to-new-instances tests, as well as on the delayed learning test, the delayed tests of transfer to new instances, and to new concepts.

These results are in agreement with those of the experiment in Phase I and again support the hypothesis of the project. That is, the class cue produced substantial learning and transfer within the previously learned class. However, unlike the results of Phase I, the specific cue produced an effect comparable to that of the class cue.

It was hypothesized that the General Cue group would produce the greatest discovery of new *concepts*. This was not confirmed. On the contrary, the general cue produced the least discovery of new concepts, even less than a Control group which had only been given experience with different types of materials. In fact, for each dependent variable, except the immediate transfer to new concepts, the mean of the Control group was higher (although not statistically significantly so) than the mean of the General Cue group. It is possible that the latter group was partially extinguished due to lack of success in the training phase.

It seems that the group which learned the most transferred the most. To provide a check on this last statement, analyses of covariance, with MA and preliminary training as covariables, were computed using only those subjects from each treatment group who had 60% or more of the items on the immediate learning test. None of the analyses were statistically significant ($p > .05$). This gives some support to the idea that transfer of discovery ability is a function of the initial learning to discover. However, such a selection procedure no doubt biased the sample and, therefore, makes any interpretations highly tenuous.

The specific cue and the class cue of this study are somewhat different from those used in the experiment of Phase I. The specific cue (e.g., green) and the class cue (e.g., color) of the present study probably have a richer history of association than the specific cue and the class cue used in the previous experiment. Most (135 of 160) of the children of this study were third graders, while those in Phase I were kindergarteners. The combination of familiar material and older children may account for the high means obtained by the Specific Cue group of this study.

In summary, either the specific cue or the class cue, e.g., "green" or "color," was effective for the teaching of concept identification. As predicted, the general cue used in this study produced the lowest mean on initial learning. Contrary to prediction, however, it did not produce the highest mean on transfer to new concepts. It is possible that the general cue did not produce any systematic way to generate possible answers and eliminate incorrect responses.

This study with meaningful materials supports the results of Phase I. The class cue can be an effective way to obtain learning, retention, and transfer, whether used with abstract materials or with more meaningful materials. The second part of Phase II, presented below, examines the generality of the results found above when French and mathematics were studied.

CHAPTER VIII. PILOT STUDY FOR THE THIRD EXPERIMENT: ABILITY OF THIRD GRADE CHILDREN TO LEARN CONCEPTS IN ENGLISH GRAMMAR (Pilot Study No. 9)

PROBLEM

Before entering the final phase of the project, it was necessary to try the stimulus materials on a group similar to the one with which the actual experiment would be conducted. The immediate problem was to determine whether average third grade children could learn the preliminary materials within a feasible length of time, i.e., in three or four training sessions. It was also desirable to try these materials in a group situation since experience had demonstrated that children in a person-to-person relationship with the experimenter could readily solve problems which proved quite difficult in a group situation.

METHOD

Subjects. All the third grade children of one elementary school (60) were used. Forty of these children were in the lower third and twenty in the upper third grade. There were 31 boys and 29 girls. (For CA, MA, and IQ, see Table I)

Materials. The subject matter was English grammer. The basic concept was part of speech. Noun, verb, adjective, and preposition were the sub-concepts used. Thirteen instances of each of these sub-concepts, a total of 55 words, were taught, as well as the concept-labels themselves.

Apparatus. The materials were duplicated and presented in 30 TMI Min-Max teaching machines with Answer-Mate attachment. These machines were made available by courtesy of the Audio-Visual Section of the UCLA Department of Education. The program was presented simultaneously to 30 children in each session. All the sheets of a session were assembled and placed inside the teaching machines before the children came into the room.

Each 8 1/2" X 11"sheet of paper contained five "frames" or items. A frame consisted of a row of four words, each with a number under it. This provided a four-choice situation. The child was instructed to select one of the responses and write the number under the response selected on the Answer-Mate tape. After he wrote the answer, he was told to roll the paper forward by manipulating the side rollers in the forward direction. The correct answer was then brought into view, at the same time as the child's response was moved under a transparent shield. The child could compare his own answer with the correct one, without being able to change his answer. During the training sessions, some of the children did not write an answer until after they had brought the correct one into view. Since the movement of the tape on the Answer-Mate attachment was very erratic, it was very difficult to detect when the child had recorded his response in scoring the tapes. For this reason in the final test the number of the correct answer was not given, only the correct word itself.

Procedure. A pre-test, four training sessions, and a posttest were administered to all the children. On the first day a test to determine whether the children could read the words to be used in the program was administered. The instructions were:

> "Find the word which says __________. Write the number under the word on your answer tape. Roll the paper forward slowly. Check your answer. Then roll to the next frame and wait...Now let's find the word which says ____________."

These instructions were repeated aloud by the experimenter for all 55 items of the first session. The presentation for the second session was as follows.

> "Today we are going to learn about some of the jobs that words do in our sentences. The job a particular word does is called its 'part'...its part in our speech, or its 'part of speech'. The first job we are going to learn about is that of the preposition. The preposition is the part of speech which tells position...where something is. Look at this sentence. (Sentence written on board) 'The boy sits on a chair.' The job of the word on is to tell us where the boy sits. He isn't under the chair or behind the chair...he is on the chair. On is a preposition and tells us the position the boy is in, in relation to the chair. He is on the chair. Now let's look at the first frame. One of the four words you see tells where something is...it is a preposition. Find the preposition and put the number under it on your answer tape. When you have written the number, move the paper forward slowly and check your answer. Then roll forward to the next frame. Find the preposition here. Find the word which tells where something is...the position."

These instructions continued for 10 frames. Then the children were told:

> "Now we are going to learn about a different part of speech. It is the noun. The noun names things. Look at our sentence again. Which words are nouns? Yes, boy and chair are nouns...they name things. Now turn to Frame 11. Find the word which is a noun...the word which names something."

These instructions were given for the next 10 items. Then:

> "The next part of speech is the adjective. This word has the job of adding something to the noun. It describes the noun. In our sentence we know that a boy is sitting on a chair, but we don't know what kind of boy or what kind of chair. It could be a big boy or a small boy, a fat boy or a thin boy, or any other kind of boy. The word which tells us more about the boy is an adjective. It adds to our information about the boy. We could also use an adjective to describe the chair. It could be a hard chair or a soft chair, a big chair or a small chair, it could be a brown chair or a green one or a yellow one. Any word which tells us more about the chair is an adjective. Let's look at the words in Frame 21. Find the word which is an adjective...one which describes something. Write the number under the adjective on your answer tape. Then check your answer. Be sure you find out which one is the adjective.

These instructions were continued through Frame 30. Then the fourth part of speech was presented.

> "The last part of speech we are going to learn about today is the verb. The verb tells action. It tells what we do. In our sentence, what is the boy doing? The boy sits. Sits is the verb. It tells what the action is. Let's see if we can find the action word in Frame 31." (Continue through Frame 40.)

The last 15 frames of this session were devoted to instruction in reading the concept-labels (noun, verb, preposition, and adjective) themselves. In each frame of this series one of these labels was included among four words, several of which closely resembled the general outline of the correct word. For instance, with verb there was very, or word, or vote; with noun there was now, and town.

Sessions three, four, and five continued the above training with the same set of words, but the frames consisted of different permutations of these words.

The posttest given on the sixth session consisted of several parts: a 10-item word identification test; a 10-item concept-label test; five items of each of the four parts of speech; and a 10-item concept-function test. The results of this test are shown in Table 1.

TABLE 1

C.A., M.A., I.Q. and Posttest Scores

	GRADE B3 N=40		GRADE A3 N=20		TOTAL GROUP N=60	
	M	SD	M	SD	M	SD
C.A.	98.7	3.9	107.1	6.8	101.5	11.9
M.A.	107.5	12.5	114.1	8.0	109.7	11.5
I.Q.	109.7	15.3	106.4	11.4	108.6	14.1

Total Test (50 items)	41.2	7.0	43.4	6.3	41.9	6.8
Word Identification (10 items)	9.7	2.8	9.4	2.2	9.6	1.5
Concept Label (10 items)	7.8	2.3	9.0	1.6	8.2	2.2
Nouns (5 items)	4.5	2.3	4.6	1.0	4.5	.9
Adjectives (5 items)	4.1	1.3	4.2	1.0	4.1	1.2
Verbs (5 items)	3.4	1.6	4.1	1.4	3.6	1.5
Prepositions (5 items)	4.0	1.2	4.2	1.5	4.0	.1
Concept Function (10 items)	7.7	2.0	7.5	2.6	7.6	2.2

RESULTS

All children correctly answered at least 82.5% of the items on the total test. Although there was a slight difference in favor of the older children, the younger children were also able to perform satisfactorily. The words used were within the grade level of the children, who scored at a mean of 96%. With three of the concepts (noun, verb, and preposition) there was no measurable difference in difficulty level. The concept of the adjective seemed to be slightly more difficult, although the difference was not statistically significant. The mean % score on this sub-test was 72.4%, contrasted to 90.6% for nouns, 82.6% for verbs, and 80.6% for prepositions.

DISCUSSION

From the above results, it seemed that these grammar materials would not prove to be too difficult for third grade children of a similar population samping (Mean I.Q. 108.6). It was therefore decided to proceed with the final experiment.

CHAPTER IX. THE THIRD EXPERIMENT: VERBAL CUES IN THE IDENTIFICATION OF ENGLISH GRAMMAR CONCEPTS

PROBLEM

The third major experiment in this project studied English grammar. The object was to test the hypothesis in a completely verbal area. No pictures were involved. Since the topic (parts of speech) is not customarily taught in the primary school curriculum, a period of pre-experimental training was required. The training provided the learnings prerequisite for the experiment proper. The children were taught a miniature structure of subject matter. The most general term "part of speech" was defined and associated to the words "noun", "verb", and "preposition". Each of these terms was in turn defined and associated with a number of specific instances. Thus far the procedure was similar to the design of the major experiment of Phase I.

However, an important difference was that these associations were not simple clusters of arbitrary connections. During the pre-experimental training the general label, "part of speech", as well as the class labels of "noun", "verb", and "preposition", were defined in terms of their function or meaning; and the children practiced using these words. The children could use the definitions or rules to decide if words encountered outside the experimental situation were examples of the concepts. In the study of Phase I this type of generalization was not possible because no meaningful rule by which to classify the groups of associations was ever taught. In the present experiment the children learned to classify 10 instances of each of the three above classes according to the appropriate class label, and to recognize the three class labels as instances of the larger concept, "part of speech".

Another important difference between the following study and the above studies was the development of seven posttests which would measure the ability to discover the solutions to problems. These tests ranged from new permutations of the same trained concepts and trained instances to a verbal concept (adjective) not taught either in pre-experimental or experimental training. The extent to which the training generalized to non-verbal materials involving concepts of shape, color, number, and size was also measured, using the materials of Experiment 1, *Phase II*.

METHOD

Subjects. All of the children in the third grade (137) and in the upper second grade (30) in a large West Los Angeles school were used. The mean C.A. of the total group was 103.0 months, and the S.D. was 4.5. The mean and standard deviation for the M.A. and I.Q., as measured by the Public School Primary Intelligence Test, Form A, were 110.4 and 14.4; and 108.8 and 11.8 respectively.

All the children were given a word identification test (see below). Only those passing this test at the 75% level were included in the study. The means and S.D.'s for C.A., M.A., and I.Q. by treatment groups are included in Table 1.

TABLE 1

Means and Standard Deviations of the MA, CA, IQ
and Pre-Experimental Measures

		MA	CA	IQ	Word Ident.	Pre-Exp. Training	No. of Trials
Group I	M	104.6	116.7	112.1	152.1	43.9	4.7
No Help N=29	SD	7.5	10.9	13.3	5.9	3.5	1.7
GROUP II	M	102.8	114.8	112.1	152.0	44.0	4.8
General Cue N=29	SD	5.2	12.6	14.8	6.0	3.1	1.8
GROUP III	M	102.9	115.3	112.6	152.9	43.1	4.7
Class Cue N=29	SD	6.0	14.1	16.1	6.3	4.1	2.1
GROUP IV	M	102.9	112.0	109.1	150.9	No Pre-experimental	
Control N=28	SD	5.0	15.9	16.2	8.2	Training	

Apparatus. The apparatus used in this study was identical to that in the first experiment for Phase II, (refer to Chapter VII). To review briefly, there were 10 booths, each equipped with an individual response panel and a set of headphones. (The microphones were not used in this experiment.) Magnetic tape played over a Wollensak tape recorder (a) controlled the presentation of the slides from a Kodak Carousel Slide Projector, (b) determined the exposure and response time for each item, and (c) delivered the same verbal instructions to each child. A master control panel registered the responses of each child, which were automatically recorded by a Clary Account-O-Punch paper tape data recorder. Each child received immediate confirmation and feedback by a green or red light on the individual subject panel.

Materials. The stimuli consisted of a variety of 35 mm. black-and-white slides along with taped verbal instructions. For the familiarization training, each slide showed five simple pictures in a single line with numbers from one to five under them (See Figure 1a). The slides for the preliminary word identification test and the pre-experimental training and testing consisted of words rather than pictures, arranged in the same manner, i.e., five in a single line with the numbers from one to five under them (See Figure 1b). For the experimental training and verbal posttests, the same five-choice situation was presented, but there was a single, unnumbered word centered above the five choice words (See Figure 1c). The top word was the model to be matched in the problem-solving task.

An intermediate typewriter, with type face smaller than that of the primary typewriter but larger than standard pica, was used to prepare the words, frames, and numbers on a white background. Since the slides used the film negative, the children saw white words projected against a black background.

Procedure. The study was divided into four successive steps. The first, preliminary training, included familiarization training and testing and was identical for all the treatment groups. The second, the pre-experimental concept training and testing, was identical for all the treatment groups except the Control group. After the pre-experimental training, the treatment groups were formed at random and the third step, the experimental training, was administered. The Control group did not receive the experimental training.

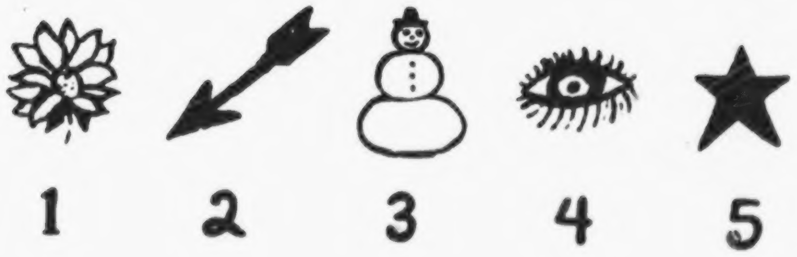
3

Step four began immediately after the experimental training and consisted of a series of posttests to measure learning and transfer. These tests were identical for all groups, including the Control group. No verbal cues were given on any test. Three weeks later, the same series of tests was given again to measure retention. A final test of generalization to mathematical concepts concluded the study. The details of each of these steps follow.

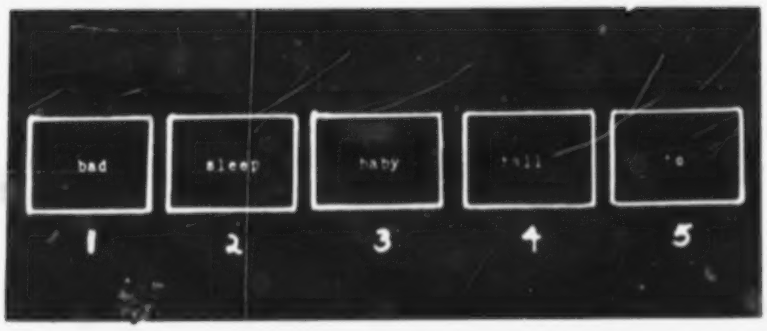
1. Preliminary training. Purpose: To familiarize children with the experimental situation and to eliminate those who had not yet acquired the skills prerequisite to the experimental tasks.

a) Familiarization. The purpose of this initial training was twofold. The purpose was first to familiarize the children with the experimental setting, the headphones, and the response panels. The second purpose was to determine whether the children would be able to respond correctly when the task involved a four-step process: (a) selecting a picture (or word) according to its spoken label; (b) identifying the number under the picture (or word); (c) identifying the numbers under the buttons; and (d) pressing the button with the same number as the selected picture.

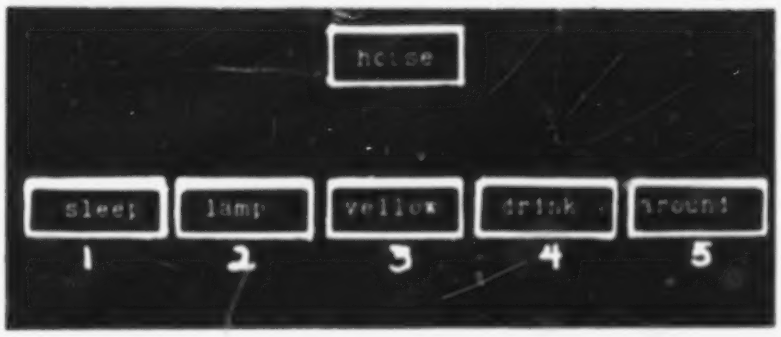
On the first day the children were given a series of 15 35 mm. black-and-white slides showing drawings of simple pictures (See Figure 1a). The first slide showed a picture of a star on the extreme left, with the number one under it. The child' s task was to push the button on his individual panel which also had the number one under it. In subsequent slides, the child was taught to press the button whose number corresponded with the number of the picture with a spoken verbal label. For instance, the instructions were of the nature: "Find the dog. Press the button with the same number as the



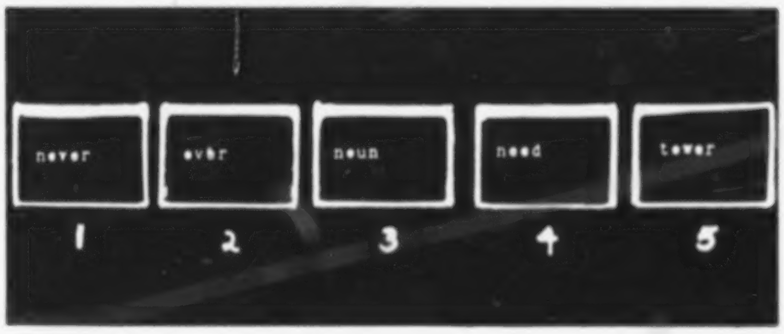
Ia. Familiarization Training


bad
sleep
baby
tall
to
1
2
3
4
5

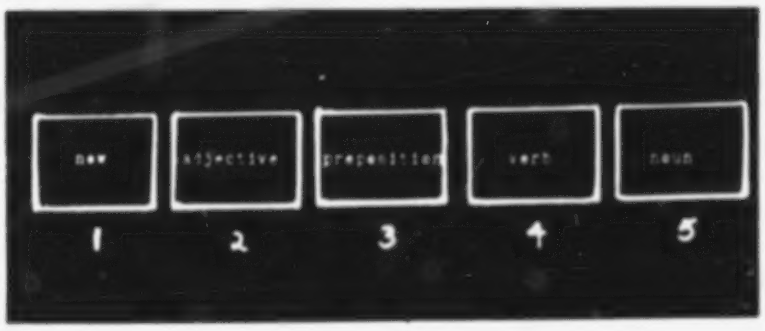
Ib. Preliminary and Pre-experimental training and Testing. Pretests 1 and 4.


house
sleep
lamp
yellow
drink
around
1
2
3
4
5

Ic. Experimental Training and Posttests


never
ever
noun
need
tever
1
2
3
4
5

Id. Pretest 2


new
adjective
preposition
verb
noun
1
2
3
4
5

Ie. Pretests 3 and 5

Fig. I SAMPLE SLIDES

number under the dog. If you get a green light, you have pressed the right button. If you get a red light, press the red light button quickly and try again." All the children were able to perform this series of operations without any difficulty.

b) Word identification. All the children were given two series of 80 slides each to test their ability to read the words which were to be used in the experiment proper. These slides presented five words in a single line; under each word was a number from one to five, from left to right (See Figure 1b). The words on each slide were chosen from a word population which included 20 nouns, 20 verbs, 20 prepositions, and 20 adjectives. Each of these parts of speech was represented on each slide at least once, in a design such that each word was presented in each of the five possible choice positions with different words in the other positions. There were 80 permutations in this series, and each of the 80 words was called for once per session.

The instructions were: "We want to see how many of these words you can read. Look at the words on the screen. Find the word which says (e.g., boy). Press the button with the same number as the word you choose. If you get a green light, you have chosen the correct word. If you get a red light, press the red light button and try again. Find (boy)." A 10-second interval was provided for each frame or item. The children's first responses were automatically recorded by the Clary paper tape data recorder. The number correct of the total 160 test items was used as the word identification score. Only those children who scored 120 or better (75%) were used. There were 154 children who met this preliminary criterion. These were ranked according to I.Q. and grade level and 28 were selected at random for the

Control group.

2. Pre-experimental training and testing. This training was designed to establish the mediators and the miniature structure of associations which would be used in the experimental phase to provide meaningful verbal cues for the treatment groups. The general cue, "part of speech", the class cues, "noun", "verb", and "preposition", and 10 instances of each of these three concepts were trained in the pre-experimental training sessions.

Five specific objectives were delineated for the pre-experimental training. Attainment of these five objectives was assessed by tests over this pre-experimental training (See Pretests 1, 2, 3, 4, and 5 described later in this section).

> 1) The child selects the correct instance (response) to a particular spoken concept label (stimulus). As previously indicated, this selection was in the context of a five-choice situation in which each of the four parts of speech was represented at least once. (See Pretest 1)
>
> 2) The child selects the written form of a spoken concept label (noun, verb, or preposition) from among five alternatives, four of which are distractors. This ability is a prerequisite to objectives 3 and 4 below. (See Pretest 2)
>
> 3) The child selects the appropriate concept label from among five alternatives, four of which are the parts of speech, in response to a stimulus such as: "Find the part of speech which names something or someone." (See Pretest 3)
>
> 4) The child uses the concept labels meaningfully to select an untrained instance as belonging to the class called for by a specific spoken label. These words were selected from the population of 20 words per concept, included in the word identification test, but not in the pre-experimental training. (See Pretest 4)
>
> 5) The child demonstrates his ability to classify a spoken word as belonging to a particular class (noun,

verb, or preposition) by selecting the appropriate written label in a five-choice situation. The slides used to evaluate this ability were the same ones that were used in 2 above, but with a different tape and a different order of presentation. (See Pretest 5)

It was particularly important to test whether the child had acquired the last ability, since the pre-experimental training consisted primarily of associations of the type $S_{\substack{\text{Concept label}\\ \text{(noun)}}}\text{---------------}R_{\substack{\text{Selection of instance}\\ \text{(book)}}}$. In the experimental training the child would be required to match words in both forward and reverse directions, e.g., in the pre-experimental training the child heard the stimulus "noun" and had to select the response "book". In the experimental task the stimulus was "book" and the required response was"noun".

$$S_{\substack{\text{Instance of Concept}\\ \text{(book)}}}\text{---------------}r\text{-}s_{\substack{\text{Concept label}\\ \text{(noun)}}}\text{--------------}R_{\substack{\text{Select another instance}\\ \text{of the same concept}\\ \text{(Banana)}}}$$

All 126 children assigned to the experimental treatments were given a minimum of five pre-experimental training sessions. Each of these sessions contained 60 frames or items, divided into six problems with 10 items per problem. There were two problems for each of the three concepts being trained. The slides used were selected from the basic set of 80 slide permutations which had been used in the word identification test. The task for each item, throughout the pre-experimental training, was to select the appropriate instance in response to a particular spoken concept label. Thus, when a slide containing the words and numbers:

white	banana	down	between	think
1	2	3	4	5

was projected, the taped instruction was: "Find the noun, the part of speech which names something or someone. Press the button with the same number as the number under the word you choose." If the child pressed button number 2 he got a green light, which told him that he had selected the correct instance of the part of speech with the concept label "noun". (See Figure Ib)

For the first five items of the first problem for each of the three concepts, the child was given a 10-second interval to respond. Then the response panel was closed and the correct answer given, e.g., "Banana is a noun. Banana names something. Banana is the name of a fruit." The response panels were closed before the answer was given because previous experience had demonstrated that when the child knows he is going to be told the answer after a short interval, he will wait for the answer before making his response. With the present procedure, the child quickly learned that if he did not respond before his light was turned off, he would lose the opportunity to get a green light.

For the remaining five items of the first problem and all the items of the second problem of each concept, the correct answer was not given and the only feedback information was a green or red light. However, since all responses had to be made before correct answers were given, all the items could be scored. The responses were recorded automatically on paper tape by the Clary data recorder, tabulated, and analyzed at the end of each day's sessions.

Session 1. Five instances of each of the three concepts were presented four times, each time embedded among four different distractor words in different positions. The order of the problems was noun, verb, preposition, verb, preposition, noun.

Session 2. Five new instances of each of the three concepts were presented as in Session 1. The order of presentation of the problems was verb, noun, preposition, noun, verb, preposition.

Session 3. All 10 instances taught in Sessions 1 and 2 were used. Each instance was presented once in each of the two problems per concept. The order of presentation was preposition, verb, noun, preposition, noun, verb.

Session 4. All 10 instances taught in Sessions 1 and 2 were used,but a different method was adopted. The first 10-item problem of a concept presented only five instances of the concept, each instance used twice in that problem. The second 10-item problem of the same concept presented the other five instances, each instance given twice. The order of presentation was noun, preposition, verb, preposition, verb, noun.

Session 5. Repetition of Session 4.

Sessions 6-10. Repetition of Sessions 3 and 4, alternately.

All the children were given the first five sessions of 60 items each. All 60 items were scored. Those children who had scored 51 or more (75%) correct on two successive sessions were given no further pre-experimental training. Although five sessions were given to all children, 19 of them achieved criterion by the second session, 6 by the third, 11 by the fourth, and 17 by the fifth. Thirteen children required an additional session, and 21 required two additional sessions. (Five children failed to reach criterion even with additional training.)

A series of five tests to evaluate level of achievement of the five objectives enumerated above followed. The scores on the last 10 items of each of these tests were combined to provide a total criterion test of 50 items. Another measure used was the number of trials required to reach the criterion of 75% in two successive pre-experimental training sessions (see Table 1).

Pretest 1. This was not a separate test but consisted of the number correct of the last 10 items on the last training session.

Pretest 2. This test consisted of 30 items. Each item or slide contained five words in a row, as in the training slides. However, one of the words was a concept label, i.e., "noun", "verb", or "preposition", and the other four words were distractors (See Figure Id). The words used in the training were not used on these slides. The taped instruction for the first slide was "Find a word which names a part of speech, one of the jobs that words do in our sentences." On the subsequent slides the instructions were simply: "Part of speech." Again the task was to select the proper word and press the button with the same number as the word. After an eight-second interval, the child's response panel was closed and the correct answer given, with additional information as to the concept-label function, e.g., "The part of speech is verb. Verb is the action word. Verb tells something we can do." Or, "The part of speech is noun. Noun is the naming word. Noun names something or someone."

The last 10 of the 30 items were scored. All children reached criterion of 7 out of 10 on this test.

Pretest 3. The 30 slides of this test consisted of five words, four of which were part-of-speech concept labels and the fifth word a distractor similar in typographical outline to one of the concept labels, e.g., now, very, adjust, or proper. The instructions were: "Find the part of speech which names something or someone." Or "Find the part of speech which tells something we can do." Or "Find the part of speech which tells place or position." (See Figure Ie) Eight children failed to meet the criterion of 7 out of 10 on this test.

Pretest 4. The 30 slides used in this test were made up of three sets, of 10 items each, of the three concepts. The first five of the 10 words in each concept-problem had been trained in the pre-experimental training sessions. The last five words had appeared in the word identification test but had not been associated with a particular concept label in the pre-experimental training. The child's task was to select from among five words the one which was an instance of a spoken concept. Only the last 10 of the 30 items were scored. Two children failed to reach the 7 out of 10 criterion.

Pretest 5. The same set of slides which had been used in Pretest 3 above, were used, but in a different random order, and with a different instruction tape. The task in this test was to listen to a spoken word (e.g., "boy"); classify it as a particular part of speech; supply the part-of-speech label of which the spoken word was an instance; and press the button with the same number as the word selected. The 10 instances of the three concepts were mixed together and presented in random order. The last 10 items were scored. Nine children failed to score 7 out of 10 on this test.

Although a 70% (7 out of 10) criterion was used for each subtest, a total score of 38 (75%) was set as the final criterion for the combined scores. Four children were dropped for failure to reach this more rigid criterion.

It was felt that stringent criteria covering each of the component skills required in the experimental training task were necessary to make certain that each child in the experiment was capable of performing the prerequisite operations.

3. Experimental Training. As a result of the above elimination processes, 28 children were dropped. In addition, 11 children had either been absent too many times to make up missed sessions or had left the school. This left 87 subjects for the experimental treatments. These children were ranked according to grade level, combined criterion score, and I.Q., and were assigned to blocks of three children each.

Within a block, each child was assigned at random into one of the three treatment groups. Twenty-nine children were thus assigned to each treatment. The means and standard deviations for C.A., M.A., I.Q., Word Identification Score, Combined Criterion Score, and Number of Trials to Criterion for each treatment group are included in Table 1. The C.A., M.A., and I.Q. of the Control group of 28 subjects who had been set aside before the pre-experimental training was begun is also presented in this table. (Page 112)

The three treatment groups included a No Help group, a General Cue group, and a Class Cue group. During the experimental training all the subjects were shown one set of 60 slides and had to solve four problems. In two of the problems the correct concept was "verb"; in the other two the concept was "noun". Only five of the 10 instances associated with each of these concepts in the pre-experimental training were used. This left five other trained instances of these two concepts for the first transfer test.

The slides for this phase were similar to those used in the pre-experimental training, i.e., they had five words in a row with a number from one to five under them. In addition, however, there was another unnumbered word, the model, centered above the choice words (see Figure 1c). The task was to select one of the five numbered words to match or "go with" the top word.

On the first slide all the treatment groups heard the same basic instructions.

> "Today we are going to play a game....Look at the first slide. You see there is one word on top, with no number under it. In the bottom row there are five words, numbered from one to five, just as in our other slides. The game we are going to play is a matching game. First you must read the word on top. Then you must read the five numbered words below it. Choose a bottom word to go with the top word."

At this point the instructions for the three treatments differed as follows:

No Help group: "The bottom word should go with the top word in some way."

General Cue group: "The bottom word should be the same part of speech as the top word."

Class Cue group: "The bottom word should be a verb like the top word." This was the only way in which the verbal cues for the treatment groups differed. In fact, it was the sole difference among treatments, since at all other times each group saw the same slides and heard the same commentary. The rest of the instructions continued:

> "All the words in this set will be matched in the same way. Look at the number of the word you have chosen. Press the button with the same number. If you get a green light, you have chosen the correct word. If you get a red light, press the red light button quickly and try again."

The instructions for the second slide for all groups were:

> "Now look at this slide. Find a bottom word that"
> (No Help) "goes with the top word in some way."
> (General Cue) "is the same part of speech as the top word."
> (Class Cue) "is a verb, like the top word."
> "Press the button with the same number as the word you choose. If you get a red light, press the red light button quickly and try again."

The instructions for the third slide were:

> "Look at the top word on this slide. Press the button with
> the same number as the bottom word that"
> (No Help) "matches the top word in some way."
> (General Cue) "is the same part of speech as the top word."
> (Class Cue) "is a verb, like the top word."

For slides four through 10 the instructions consisted of the treatment cue alone.

No Help: "Match the top word."
General Cue: "Match the part of speech."
Class Cue: "Match the noun (or verb)."

All the treatment groups received only the No Help instructions: "Match the top word" for the last five frames of each of the four problems. These items were scored and comprised a 20-item test over experimental training.

The second day of experimental training used the same set of slides as the first day and identical verbal instructions for all except the first two slides which followed the same general pattern as the first day but were somewhat shorter.

4. Posttests. Posttest A: Learning Test. Same concepts, same instances. The 20 scored items of the second day of experimental training comprised the first posttest -- the test over learning.

Thirteen children in the No Help group, 9 in the General Cue group, and 8 in the Class Cue group did not attain a score of 75% and were given another session with the same tape and slides as the second day of experimental training. The scores on this test were used as the learning scores for these children. The Control group was given the same sequence of slides, with the same instructions as the No Help group.

Posttest B: Transfer to new instances of the two concepts used in the experimental training. These instances had been associated with the appropriate concept labels in the pre-experimental training, but not in the experimental sessions. There were 20 frames for each concept -- noun and verb. The last 10 items of each problem were scored and combined into a single score for this test.

Posttest C. Transfer to untrained instances of the trained concepts, noun and verb. These words had been included in the word identification test, but had not been associated with the concept labels. 20-item test.

Posttest D. Transfer to a new learned concept, preposition. This concept, trained in the pre-experimental training sessions, had not been used in the experimental training. Only the ten trained instances of this concept were used. The last 10 items of each set of 20 slides was used as the test score.

Posttest E. Transfer to new trained concept (prepositions) and untrained instances.

Posttest F. Transfer to a new, untrained concept (adjective). Although the words used in this test had been evaluated for readability in the word identification test, they had not been associated with any concept label. 20-item test. Table 2 summarizes the nature of the tests.

TABLE 2

Description of Posttests

TEST	Preliminary Training		Experimental Training	
	Concepts Taught	Instances Taught	Concepts Taught	Instances Taught
A	+	+	+	+
B	+	+	+	-
C	+	-	+	-
D	+	+	-	-
E	+	-	-	-
F	-	-	-	-
G	-	-	-	-

Immediately after Posttest F, the children were asked to indicate, by pushing one of the five buttons, how they liked working the machines.

Three weeks later the children were called back for retention tests, which included the same posttests described above, using the same slides but in a different order. In addition, a test of remote transfer was given. This was an attempt to determine whether the discovery experience with verbal materials would have any transfer value with completely non-verbal materials. The slides from Experiment 1 of Phase II were used for this purpose. These slides involved matching problems with the concepts of size, number, shape, and color.

All the training and testing of this experiment occurred in a classroom which was reserved for the experiment. The children were brought to the room in groups of 10. Each session lasted approximately 12 minutes.

RESULTS AND DISCUSSION

As in the above experiments, the assumption of homogeneity of variance for each dependent variable was tested and was not rejected. The data from all subjects were analyzed by analyses of covariance. In order to provide a test of variance among the three treatment groups alone, the Control group was not included in one set of the analyses. In the second set of analyses of covariance all four groups were used.

TABLE 3

Summary of the Analyses of Covariance for the Experimental Groups and the Control Group with MA as the Covariable and Tests of Ability to Discover as the Dependent Variables[1]

Immediate Tests

	A Learning	B Trans.	C Trans.	D Trans.	E Trans.	F Trans.
df	3,110	3,110	3,110	3,110	3,110	3,110
MS_b	540.95	420.31	212.34	128.21	228.53	3.92
MS_w	15.40	24.11	21.72	22.41	24.35	8.97
F	35.14**	17.43**	9.78**	5.72**	9.39**	.44

Delayed Tests

	A Learning	B Trans.	C Trans.	D Trans.	E Trans.	F Trans.	G Trans.
df	3,110	3,110	3,110	3,110	3,110	3,110	3,110
MS_b	373.55	456.81	408.74	216.51	187.99	11.96	9.20
MS_w	18.78	26.26	22.88	27.08	25.06	17.17	11.05
F	19.89**	17.40**	17.86**	8.00**	7.50**	.70	.83

$^{**}p<.01$

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[1] For a description of the Posttests see Table 2. From A to G the tests are ordered in terms of increasing remoteness from original learning.

The first question asked of these results was whether the second and third grade children in the experimental groups learned something about English grammar during training which helped them on the posttests.

TABLE 4

Means and Standard Deviations of the Immediate Tests*

No. of Items		A Learning (20)	B Trans. (20)	C Trans. (20)	D Trans. (20)	E Trans. (20)	F Trans. (20)
GROUP I No Help N=29	M	14.9	12.2	9.5	15.2	12.3	6.0
	SD	5.3	6.2	5.0	5.2	5.6	3.7
GROUP II General Cue N=29	M	17.0	13.6	9.9	15.7	13.6	5.6
	SD	3.1	5.5	5.9	4.9	5.8	2.6
GROUP III Class Cue N=29	M	17.7	15.8	10.0	17.1	11.9	5.9
	SD	3.6	3.7	4.8	3.6	4.6	3.7
GROUP IV Control N=28	M	7.8	6.4	4.1	11.5	6.6	4.8
	SD	3.6	3.9	1.8	5.5	3.8	2.1

*For a description of the Posttests, see Table 2. From A to G the tests are ordered in terms of increasing remoteness from original learning.

From Table 4 it is apparent that the experimental groups demonstrated a much higher level of performance than the Control group on the first five of the posttests given immediately at the conclusion of the experiment. Only on the last immediate test, Test F, which presented a completely unfamiliar concept, was there a lack of significant difference. The results indicate that the young children in the experimental groups did learn the grammar concepts. These grammar concepts are ordinarily not encountered in elementary schools for at least two additional years. The performance of the two highest experimental groups on the posttest A represents a high degree of competency in using the concepts of noun and verb. These youngsters not only learned the concepts, but they learned to identify them in later problems when no verbal assistance was given.

TABLE 5

Means and Standard Deviations of the Delayed Tests*

No. of Items		A Retention (20)	B Trans. (20)	C Trans. (20)	D Trans. (20)	E Trans. (20)	F Trans. (20)	G Trans. (20)
GROUP I No Help N=29	M	15.0	15.4	11.7	13.9	13.4	7.7	33.0
	SD	5.2	5.2	5.8	5.8	4.6	4.3	3.5
GROUP II General Cue N=29	M	17.1	14.7	13.8	15.3	13.2	6.6	33.3
	SD	3.5	5.7	4.9	5.9	5.9	4.1	3.7
GROUP III Class Cue N=29	M	17.6	16.9	14.6	15.2	13.9	7.0	32.1
	SD	3.9	4.6	5.1	4.0	4.2	5.0	3.0
GROUP IV Control N=28	M	9.2	7.8	6.1	9.2	8.3	6.1	32.2
	SD	4.9	4.8	2.9	5.0	5.1	2.9	2.9

*For a description of the Posttests, see Table 2. From A to G the tests are ordered in terms of increasing remoteness from original learning.

But did this learning on the part of the experimental groups last over a period of time? The data presented in Table 5 indicate that the performance of these groups appeared to be as high, if not higher in most instances, than was true at the immediate conclusion of the experiment. Again on Posttests A - E the experimental groups were far beyond the Control group in their ability to identify the grammatical concepts which they had encountered in their training almost a month earlier. Only on the transfer test involving a completely unfamiliar concept, Test F, was there again no significant difference between the experimental and control groups.

The next question asked of the data was if there were any significant differences among the experimental groups, when the Control group was not included in the analyses.

TABLE 6

Summary of the Analyses of Covariance for the Experimental Groups with MA and Pre-experimental Training as the Covariables and Tests of Ability to Discover as the Dependent Variables[1]

Immediate Tests

	A	B	C	D	E	F
	Learning	Trans.	Trans.	Trans.	Trans.	Trans.
df	2,82	2,82	2,82	2,82	2,82	2,82
MS_b	71.58	119.41	7.58	3.84	11.59	1.82
MS_w	13.50	22.14	21.09	20.02	21.05	10.07
F	5.30**	5.39**	.36	1.92	.55	.18

Delayed Tests

	A	B	C	D	E	F	G
	Learning	Trans.	Trans.	Trans.	Trans.	Trans.	Trans.
df	2,82	2,82	2,82	2,82	2,82	2,82	2,82
MS_b	65.01	58.92	83.14	2.26	1.12	9.73	7.63
MS_w	15.20	22.04	23.39	25.38	22.40	19.17	11.58
F	4.28*	2.67	3.55*	.89	.50	.51	.66

*$p<.05$
**$p<.01$

[1] For a description of the Posttests see Table 2. From A to G the tests are ordered in terms of increasing remoteness from original learning.

Among the experimental groups, it is quite clear from Tables 4, 5, and 6 that the Class Cue group and the General Cue group were superior to the No Help group on the immediate tests A and B, and delayed tests A and C. These were the tests in which subjects were asked to discover concepts they had encountered during both preliminary and experimental training. There was no significant difference between the General Cue group and the Class Cue group. This suggested that the cue "part of speech" had been learned as well as the class cues, i.e., "noun" and "verb".

It is of some interest to compare these results with those obtained in the first experiment of this project. The difference in results between the General Cue and the Class Cue group was negligible in the present experiment, but considerable in the first study. The two experiments are comparable on many grounds. The materials used in the test items were quite familiar to the subjects; pictorial material for kindergarten youngsters and the words used for the third grade children had been selected on precisely this basis of familiarity.

The terms which were used as general cues and class cues, respectively, were new to all the subjects; for the kindergarten children the labels "la" and "le" as well as the word "article" had not been previously experienced by the subjects. The third grade children had not experienced the grammatical terms "noun" and "verb" and the phrase "part of speech", at least to any great extent.

The major difference might be due to the arbitrary nature of the concepts in the first experiment as contrasted to the more meaningful ones used in the present ones. The concepts were defined in a systematic way which may have aided transfer. It should be noted that the first experiment was carried out with kindergarten children while the subjects in the third investigation were third graders. It is quite possible that the differences in age and MA could result in a difference in ability to use these terms in a mediating fashion. That is, the general cues are helpful to the older children.

From Table 4, the class cue has the highest mean on the learning test (A) and the immediate transfer test to new instances (B). From Table 5, the class cue also has the highest mean on the retention and delayed transfer to new instances (C) test. These findings are in close agreement with the hypotheses and with the results on Experiments 1 and 2. However, in the present experiment, the general cue also seemed to have produced an effect upon learning to discover and transfer of discovery to new instances, although its effect was not usually as great as that produced by the class cue.

On the far transfer tests which involved new concepts, Tests D-G, there was no significant differences among the experimental groups. The effect of cueing, therefore, along with the preliminary training, fails to show transfer of this broad variety. This finding also agrees with the results from the study on mathematics. The first experiment did not have a transfer to new concepts test. The affectivity ratings evidenced no significant difference among the treatment groups. The treatments probably did not produce sizable differences in student reaction to the experimental situation.

The children of the Class Cue group were taught to discover through a fairly directed procedure. Their ability to discover was intimately related to the specific concepts they learned during training. That children can be taught to "discover" through explicit direction from a teacher may seem to violate common sense. However, the finding supports the hypothesis, and the effect was obtained after only two or three days of experimental training. The use of a class cue during training appears to be an effective way to teach children to learn to solve problems presented later in the absence of cues, but where identification of these same concepts is critical.

It is also clear that the children were not taught how to discover solutions to far different problems from those they encountered in the experiment. To teach children to discover in highly unfamiliar situations was an ambitious end for the general and no help cues employed here.

As was stated in Chapter 1 above, the project did not attempt to find the "best" way or combinations of ways to teach children to discover. Instead, the objective was to study carefully the effect of one important variable upon intellectual behavior. The effects of this variable, cueing, were consistent and reliable for the three studies of this project. They indicate that children can be taught to discover when the development of concepts is emphasized. The three experiments also indicate that to teach children to discover solutions where previously learned concepts no longer apply is a difficult and complex affair.

To obtain this type of transfer, if possible, will probably involve more than the presentation of the types of verbal cues used in this study. However, since the purpose of this project was to find the effects of these verbal cues upon learning and transfer, rather than to find the one "best" way to teach concept identification, the project seems to have produced much useful and consistent results about this one, specific part of teaching concept identification. These findings are summarized and discussed in the next chapter.

CHAPTER X. SUMMARY AND CONCLUSIONS

The central problem for this project was the study of the effects of different kinds of verbal cues, given during training, upon the ability to discover solutions to problems in the absence of cues. Preceded by a total of nine pilot studies, three major experimental investigations, each involving about three months of classroom work, tested the major hypothesis of the project with three different types of materials. The project dealt with the area of concept identification and "discovery" learning. A genuine attempt was made to separate and to define operationally the independent and the dependent variables which often occur in studies on "discovery" learning and concept identification.

One important independent variable in these studies is the type of verbal cue presented to the learner. Important dependent variables are (a) transfer of problem-solving ability to new problems which can be solved by selecting one of several previously learned concepts; and (b) transfer to problems which involve the generation of new concepts. The above variables were studied with primary school children in a controlled, automated classroom setting which was designed and built for the experiment. (The studies are easily replicable because all stimuli were recorded on slides and tape.)

One hypothesis was developed from related research and from the mediation hypothesis. The hypothesis stated that the specificity of verbal cues during training is inversely related to the breadth of transfer of the ability to discover, as measured by posttests on problem-solving. Specificity of cue as an independent variable was described in terms of the breadth of the class of responses a cue controlled. A cue which controls a narrow range of responses was referred to as a specific cue. Cues which controlled many classes of behavior were referred to as general cues. Between these two cues was the class cue. It was a cue which controlled the responses of more than one specific cue.

The relationships between cues and responses are usually difficult to understand because the associations to the cues have been acquired by the subjects during their previous experience. When the experimenter has little knowledge about the subjects' previous experience with given cues, it is difficult to formulate precise predictions regarding the relationship between specificity of cue and problem-solving acquisition. In this project, therefore, the tasks were selected so that it was possible either to define quite clearly such a relationship or, preferably, to have the child acquire a miniature structure of knowledge during a period of instruction prior to the experiment proper. In two of the three major investigations of the project all subjects were given an extensive period of instructions during which they learned in a predetermined pattern the associations between cues and responses. On the basis of information regarding the relevant past history of each subject, it was therefore possible to make a prediction about how effective different types of cues would be.

To make clear the relationship between specific, class, and general cues, the associations taught the subjects were arranged in the form of a hierarchy. The specific cues controlled a narrow group of responses, class cues controlled the specific cues, and a general cue controlled the class cues. The investigation attempted to study a sample of the subject matter the child might encounter in school. The major focus of this project was not to develop a teaching program. Rather, it was to study, in a milieu comparable to classroom conditions, the important process of verbal cueing.

The two aspects of the major hypothesis of this study were (a) the use of a class cue during training is more effective than the use of a specific cue (a direct prompt of the answer) or a general cue (an indirect hint) when the criterion is ability to discover in the absence of cues solutions to other problems within this class; (b) on transfer tests, where problems are different in principle from those encountered during the problem-solving training, the general cue is superior to either the class or specific cues in producing ability to discover solutions.

Three different major experiments were carried out, each involving about three months of training and testing with 50 to 150 children at the kindergarten-primary level. For all three studies the same general kind of matching to sample task was adopted.

Each subject was required to select in multiple-choice fashion a picture, a figure, or a word which matched a model with respect to a dimension to be discovered. On the criterion tests subjects were given no cues; they were required to find, through their own resources, the appropriate basis for matching.

Each session for these investigations was carried out with a small group of 10 or fewer children at a time. For each experiment, slides and recorded sound were presented, responses recorded, and appropriate confirmation given, all by completely automated equipment.

In the first experiment, kindergarten children were taught a hierarchy of associations. They were then posed the task of matching pictures which required for their solution that they draw upon this knowledge. The second investigation carried out at the third grade level dealt with rudimentary mathematical concepts. The problems involved matching-to-sample on the basis of size, number, shape, or color. The third investigation, also carried out at the third grade level, involved the use of relationships in English grammar.

In all these investigations a common set of procedures was carried out. All children were tested before the experiment began for their knowledge of the hierarchical structure relevant to the experiment. In two of the three investigations a considerable period of time was spent in teaching the children this basic aspect of the subject. But in all cases children were not used for the experiment unless they demonstrated a satisfactory score on a test over preliminary training. Then they were individually assigned at random to the treatment groups.

During the experimental training proper, four treatment groups were set up in each investigation. During the problem-solving training these groups were given different kinds of verbal assistance. In each experiment one group was given a class cue. A second group was given a general cue. A third group was given a specific cue or a no help cue; and a fourth group was used as a control group.

To measure learning and transfer of ability to discover, a number of subtests were used. One of these assessed the amount of learning on the specific problems adopted for the experimental training. Other tests sampled the competence of the subjects on tasks which differed to varying extents from the experimental training. It was possible to measure transfer as a function of the kind of cues received, whether specific, class, general, or none at all.

The results of the three experiments were consistent and clearly supported the first part of this hypothesis. In each of the three investigations the group which was given class cues during training was always significantly higher than at least one of the other two experimental groups on tests involving, in the absence of cues, the discovery of solutions to problems of this class. In no case was any group significantly higher than the Class Cue group on this variable.

The second aspect of the hypothesis was not supported by the results. In every case where the General Cue group was favored by the hypothesis, no significant differences were obtained in the predicted direction.

Although the major results of the study are easily summarized, they deserve further discussion and elaboration. It appeared somewhat surprising that the Class Cue group was able to perform well in the discovery situation on the posttests. The group was never presented with a pure discovery situation during training. Instead, they were given the relevant cue with every problem during the training situation. Nevertheless, when presented with the posttest where they were not told the appropriate answers, they were able to "discover" the solutions quite well.

Some evidence about the motivational results of learning by discovery was uncovered. For example in the mathematics study, where previously learned concepts were used, the general cue was not as effective in producing learning as the other two cues. Consequently, at the end of four days of instruction a large proportion of this group had failed to attain criterion although all the subjects in the other two groups had reached this level. It was necessary, therefore, to supply one to three days additional training for these children. The members of this group showed very little improvement during this additional period of training. In fact, the experimenter noted that many of these pupils were showing some aversive reactions to the experiment. For this reason the additional training was terminated. (While it would have been very easy to have given these groups additional hints or cues so that they could have learned, this was not done, to preserve the integrity of the definition of the general cue treatment)

From the above incident, there was support for the thesis that learning by discovery is sometimes risky. It may be true that those who "discover" a principle or solution to a class of problems find the experience exhilarating and their efforts are strongly reinforced. However, the students in the General Cue group did not often succeed, perhaps because the stimuli were of ordinary objects which probably have many previously learned dimensions. This failure to discover may result in negative reactions, especially when the child continues working on a problem for a long time. Under these conditions he may actually give up or find the task extremely distasteful.

Under directed learning, where a high degree of guidance is provided for the student, the learner may be less "ego involved". If he succeeds he recognizes that it was with considerable assistance. On the other hand, if he fails he can readily attribute his failure to poor instruction. In a discovery-learning treatment group, however, the student is cast upon his own resources and faces the possibility of a much greater boost or threat to his ego. The possibility of discovery learning producing positive or negative affectivity was discussed by Wittrock earlier (1963c, p. 185).

> "Independent effort is highly valued by many members of our society. By attempting several responses before producing a correct or divergent response, which is reinforced, the socially valued motive of independent effort is intermittently reinforced. Assuming a learner history of reinforcement for independent effort, persistent behavior may be produced. It would also be expected that the less directed techniques would have higher affectivity loadings (either positive or negative) than the more directed techniques."

It does not seem that discovery learning is necessarily intrinsically motivating or pleasant. The motivation appears to be dependent on several factors.

One of the obvious problems facing all investigators of problem-solving, and one which was acute in this project, is that one must study certain variables at the expense of others. It is impossible to hold all variables constant at the desired levels. For example, if time is held constant for all treatment groups, the proportion of subjects who learn may not be the same for each treatment group. When ability to transfer is assessed, differences between treatment groups may be obtained simply because the groups were not equated in terms of the amount learned during training, even though they were equated for total time. For the first of the three experiments of this project, training time was held constant, initial learning varied among experimental groups, and the results were interpreted in this light. This procedure does not allow one to answer the question, "If all groups had learned the same, would there then be a difference in transfer?" However, the procedure does enable one to study the preliminary and more fundamental question, "Which, if any, of the ways under study produces initial learning?"

For the second experiment, however, an attempt was made to hold initial learning constant by varying the amounts of training time. But simply varying the training time in this experiment was not sufficient to bring all three experimental groups to an acceptable level of learning.

A course of action available to experimenters facing this sort of impasse is to try to bring all treatment groups up to the same criterion of learning through the use not only of different amounts of training time but through introducing variations within a treatment. Gagné and Brown (1961), for example, supplied additional hints to some members of their "discovery group" if they did not arrive at the solution within a reasonable period. Such a procedure may be highly desirable if one is concerned with a practical formulation, but not necessarily in an analysis, of a highly effective teaching program for problem-solving. Such a procedure makes the interpretation of the experimental results difficult. Where one is concerned with studying the effects of a particular type of treatment, such as verbal cues in this investigation, varying within one treatment group the amount of assistance offered the students affects the integrity of the treatments.

In the third experiment, special care was again taken to provide additional training time where necessary. Although the No Help group failed to attain an adequate level of initial learning even under these conditions, the mean performance of the General Cue and the Class Cue groups was nearly identical and permitted a study of the hypothesis about the general cue and its effects upon transfer to new concepts after both had learned equally well. According to the second part of the hypothesis, therefore, greater transfer to new concepts should have been exhibited by the General Cue group. In spite of the fact that an excellent set of measures of transfer had been devised for this experiment, no significant differences in transfer to new concepts were found. It seems unlikely, therefore, that one can account for such lack of transfer simply because the General Cue group failed to learn as much during the experimental training.

In this project, when time was held constant, the use of a general cue was less effective than a class cue on all measures of learning. When time was permitted to vary not only did the General Cue group take far more time to learn but in one study they did not learn as well as the Class Cue group. In the final study, the General Cue group took longer to reach the same level of learning as the Class Cue group but still failed to demonstrate any superior performance on transfer measures.

The results of this project indicate that whether or not discovery learning is effective probably depends upon the learner's history of associations to the problems and the cues as well as upon his acquired methods of discovering. The fundamental problem for future research is not the global and diffuse issue of whether discovery learning is or isn't as effective as some other way to learn. The answer to such a question probably lies in an analysis of how one has already learned how to learn. The fundamental problem is to find ways to develop or improve in children systematic methods of generating possible answers and of eliminating the incorrect ones. The important finding of this study is that the ability of children to do these things seems to be related to, among other elements, the types of cues and the problems they have been presented with in the past.

The effectiveness of a cue may be predicted on the basis of its previous associations and on the type of test used to measure its effect. A class cue or a cue for concepts appears to be an effective one to train ability to discover solutions to problems which involve the previously learned concepts.

In teaching children to discover solutions to later problems where no cues will be present, an effective way is to give a series of training problems each of which is accompanied by a cue for the label of the correct concept. At least such guidance seems more appropriate than highly indirect cues, no cues at all, or specific, unexplained answers. These latter approaches, even though they duplicate the criterion test conditions more exactly, are of less value than the use of a more direct verbal cue during training.

The above generalization must be severely limited to situations, subjects, and subject matter highly similar to those employed in this project, and especially must it be limited to those problems which can be solved by applying one of several previously learned concepts.

It is encouraging that children can be taught to discover solutions to certain types of problems. Their ability to discover seems to be very closely related to how well they have learned the pertinent concepts initially. Whether there is an ability to discover that is not dependent on specific subject matter content is open to question and deserves further research.

As used in this study, the procedure of defining abstract concepts such as "discovery" in operational terms of independent and dependent variables allows one to analyze functionally the relations between them. The procedure appears to be one effective way to obtain data which admit of interpretation on specific parts of issues, even if the data do not find the "best" way to teach or do not solve entire issues in one series of experiments. A functional analysis of specific stimuli and responses appears to be an important way to study some of the very complicated issues and problems of educators.

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APPENDIX[1]

Preliminary Session 1. (Familiarization Training)

Hello boys and girls. Can you hear me clearly? If you can't, raise your hand ... Now let's all pretend that our booths are space capsules and we are pilots. We each have our own control panels. Today we are going to learn how to operate them. You see the little gray box in front of you. It has five buttons in a row. On the front of the box, closest to you, is a little glass window. It is your "go" light. It is not on now because you are not yet ready to go--to press a button, that is. Now I am going to show you a slide. Look at the screen in front of you. There is a picture of a star with a 1 under it. When I turn your go lights on I want you to press the button with the same number as the number under the star. Ready Your go light is on. Press the button for the star, the button with the number 1 under it. If you get a green light, you have pressed the right button. If you get a red light, press the button with the red light in it. The red light will go out and you will have another chance to press a button. You cannot get a green light while your red light is on, so be sure to put the red light out first ... Very good. Now let's look at the next slide. This slide has a star with a 1 under it, and it has a flower, with the number 2 under it. When your go light goes on I want you to press the button with the same number as the flower. Ready? Go. Your go light is on. Press the button with the same number as the number under the flower ... Remember, if you get a red light, press the red light button quickly and try again ... That was very good. Now I want everyone to see what happens when you press the wrong button. Everybody press button number 1, the button for the star, not the flower. Go ahead. Press button number 1. You see, you get a red light. All right, now press the button that has the red light in it. The red light will go out. Now you can press the correct button, the one which is the same number as the number under the flower, number 2. Let's see everyone press button number 2, the button with the same number as the number under the flower ... Now look at this slide. Find the snowman. Look at the number under it. Then press the button with the same number as the number under the snowman (3). If you get a green light, you have chosen the correct picture. If you get a red light, press the red-light button quickly and try again. ... (Repeat for Snowman (5); arrow (4); star (2); flower (3); arrow (5); snake (4); house (5); dog (3); fish (4); eye (1); arrow (2).)

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[1] The slides used for each session are immediately following the instructions for that session.

Preliminary Sessions 2 and 3[1] (Word Identification Test)

Hello boys and girls. Today we are going to see how many of our words we can read. Look at the first slide. There are five words, each with a number under it. I'm going to say one of these words. Find the word I say. Look at the number under it. Then press the button with the same number. Ready. The first word is down. Find the word which says down. Look at the number under it. Press the button which has the same number. If you get a red light, press the red light button and try again. Now look at this slide. Find the word which says on. Press the button with the same number as the word you choose. If you get a green light, you have chosen the correct word. If you get a red light, press the red light button and try again. ...

[1] Session 3 used the same tape and slides as Session 2.

Now find the word which says green. Press the button with the same number as the word you chose....

Find swim. Press the button with the same number...

In (From this point, the stimulus word alone was given.)

Repeat for remaining words, 6-80.

Word Identification Slides

1	pencil	red	run	down	lamp
2	on	baby	old	sit	sweet
3	outside	from	doll	green	eat
4	up	dog	big	swim	bed
5	book	good	sleep	in	hit
6	play	apple	jump	around	bad
7	drink	young	ball	across	long
8	boy	skate	tall	to	inside
9	talk	girl	under	soft	wash
10	pretty	at	short	lady	dig
11	over	below	cry	man	hard
12	tree	look	table	little	behind
13	open	yellow	banana	before	chair
14	above	close	ask	fat	paper
15	up	dog	big	swim	bed
16	between	ask	by	eat	blue
17	across	cat	dig	yellow	little
18	long	pencil	inside	bed	play
19	run	pretty	below	wash	tree
20	white	banana	down	between	think
21	jump	on	apple	young	below
22	bad	sleep	baby	ball	to
23	under	boy	look	hard	sit
24	cat	to	hard	hit	up
25	doll	lady	drink	at	small
26	in	soft	green	table	open
27	around	small	girl	close	from
28	lady	tall	eat	house	over
29	big	book	up	by	ask
30	blue	talk	behind	by	good
31	open	yellow	banana	before	chair
32	dog	across	above	open	old
33	eat	above	book	boy	fat
34	good	dig	before	skate	apple
35	hard	behind	ball	cry	baby
36	man	blue	over	talk	at
37	sleep	sit	dog	pretty	down
38	paper	swim	white	drink	under
39	tall	inside	read	eat	pencil
40	by	lamp	think	big	ball

41	red	doll	in	girl	drink
42	baby	short	to	jump	big
43	near	play	open	white	man
44	before	big	cat	dig	across
45	cry	near	good	outside	boy
46	table	under	wash	small	jump
47	across	cat	dig	yellow	little
48	fat	man	hit	up	house
49	chair	long	bed	run	on
50	young	ball	chair	from	look
51	close	around	soft	banana	young
52	to	hit	long	tree	tall
53	soft	between	man	apple	read
54	skate	up	lady	bad	doll
55	sweet	think	around	dog	soft
56	apple	fat	little	ask	by
57	down	old	pencil	sleep	around
58	dig	paper	outside	tall	table
59	little	wash	house	above	sleep
60	old	by	close	book	green
61	think	green	across	look	lady
62	sit	house	red	under	pretty
63	from	open	tree	blue	talk
64	short	over	talk	baby	before
65	ball	jump	paper	good	above
66	at	hard	sit	think	dog
67	below	tree	blue	long	read
68	look	eat	boy	near	yellow
69	inside	bad	between	play	short
70	green	in	yellow	pencil	cry
71	small	bad	swim	doll	between
72	ask	chair	pretty	inside	book
73	behind	down	play	old	run
74	girl	drink	at	sweet	banana
75	wash	table	young	behind	girl
76	cat	to	hard	hit	up
77	read	little	lamp	on	in
78	lamp	run	from	red	outside
79	banana	sweet	skate	over	swim
80	soft	between	man	apple	read

PRE-EXPERIMENTAL TRAINING: SESSION NO. 1

Today we are going to learn three jobs that words can do--three parts of speech. The first one we'll do today is the noun. The noun is the part of speech which names something. Let's look at the first slide. Find the noun--the naming word--here. Press the button for the word you choose. If you get a red light, press the red light button and try again. Banana is the noun; it is the name of a fruit. Press the button for the noun, the naming word, here. Book is the noun. Book names something you can read. Press the button for the noun, naming word, here. Boy is the noun. Boy is the name of a person. Press the button for the noun, the naming word. Tree is a noun. Tree names a kind of plant. Press the button for the noun. Dog is the noun. Dog names a kind of animal. (Instructions for slides 6-10: Find the noun, the naming word.)

Now let's find a different part of speech--the verb. The verb tells what we can do. It is the part of speech which tells the action. The verb is the action word. On this slide find the word which tells what you can do--the action word. Press the button for the word you choose. Remember, if you get a red light press the red light button quickly and try again. Cry is the verb. It is something you can do. Press the button for the verb, the action word, here. Hit is the verb. It is something you can do. Press the button for the verb, the action word, here. Dig is the verb. It is something you can do. Press the button for the verb. Run is the verb. It is something you can do. Find the verb. Read is the verb. It is something you can do.
(Slides 16-20, Find the verb, something you can do).

Very good. Now let's learn another part of speech--the preposition. The job of the preposition is to tell place or position--it tells where something is. Look at this slide. Press the button for the word which tells place or position, where something is. Inside is the preposition. It tells where something is. The boy is inside the house. Find the preposition, the word which tells place or position; behind is the preposition. It tells where something is. The boy is behind the house. Find the preposition, the word which tells place or position; under is the preposition. It tells where something is. The ball is under the table. Find the preposition, the word which tells position. Before is the preposition. The girl came before the boy. Before tells position.

(Slides 26-30, Find the preposition).

Very good. Now let's find some more verbs--the action words which tell what you can do. Find the verb--the action word, the word which tells what you can do. (Slides 31-40, Find the verb.)

Now let's find some prepositions--the words which tell place or position. (Slides 41-50, Find the preposition.)

Good. Now let's find some more nouns--the part of speech which names things. Find the noun, the naming word here. (Slides 51-60, Find the noun.)

That was very good. That's all for today.

Slides for Pre-Experimental Training

Session No. 1

	NOUNS
1	banana
2	book
3	boy
4	tree
5	dog
6	dog
7	book
8	boy
9	tree
10	banana

	VERBS
11	cry
12	hit
13	dig
14	run
15	read
16	run
17	hit
18	read
19	cry
20	dig

	PREPOSITIONS
21	inside
22	behind
23	above
24	under
25	before
26	before
27	under
28	inside
29	behind
30	above

	VERBS
31	read
32	run
33	hit
34	cry
35	dig
36	run
37	read
38	dig
39	hit
40	cry

	PREPOSITIONS
41	behind
42	before
43	above
44	inside
45	under
46	before
47	under
48	inside
49	above
50	behind

	NOUNS
51	dog
52	boy
53	tree
54	banana
55	baby
56	dog
57	book
58	boy
59	tree
60	banana

PRE-EXPERIMENTAL TRAINING: SESSION NO. 2

Today we are going to have some more practice at recognizing the parts of speech--the jobs that words do in our sentences. Let's start with the part of speech called the verb. Remember, the verb is the action word. The verb tells what we can do. Look at the first slide. Which word here is the verb--the word which tells what we can do? Press the button for the word you choose. If you get a green light, you chose the right word. If you get a red light, press the red-light button quickly and try again. The verb is eat. You can eat an apple. Eat is something you can do. Eat is a verb. Find the verb--the action word here. Press the button for the word you choose... The verb is open. You can open the door. Open is something you can do. Open is a verb. Press the button for the verb---the action word. The verb is ask. You can ask a question. Ask is something you can do. Ask is a verb. Press the button for the verb--the action word. The verb is talk. You can talk to your friend. Talk is something you can do. Talk is a verb. Press the button for the verb. The verb is think. You can think of the answer. Think is something you can do. Think is a verb. (Slides 6-10, Find the verb--the action word).

Now let's try finding another part of speech..the noun. The noun is the naming word. It names something. Look at this slide. Find the naming word here. Press the button for the word you choose. If you get a red light, press the red-light button quickly and try again. The noun is apple. Apple is the name of a fruit. Apple is a noun. Press the button for the noun, the naming word, here...The noun is baby. Baby is the name of a person. Baby is a noun. Press the button for the naming word, the noun...The noun is pencil. Pencil names something you write with. . Pencil is a noun. Press the button for the naming word, the noun. The noun is man. Man is the name of a person. Man is a noun. Press the button for the noun, the naming word..The noun is cat. Cat is the name of an animal. Cat is a noun. (Slides 16-20).

Very good. Now let's find the preposition, the part of speech that tells place or position. Press the button for the preposition..the word that tells where something is. The preposition is in. In tells where something is. The pencil is in the box. In is a preposition. Press the button for the preposition, the word that tells place or position. The preposition is across. Across tells where something is. The boy is across the street. Across is a preposition. Find the preposition, the word that tells place or position...By is the preposition. By tells where something is. The man stood by the window. By is a preposition. Press the button for the preposition, the word that tells place or position. She went to the store. To is a preposition . Find the preposition, the word that tells where something is..At is the preposition. Now you are at school. At tells place or position. At is the preposition. (Slides 26-30 Find the preposition, the word that tells place or position.)

Now let's find some more nouns, the naming words. (Slides 31-40, Find the noun, the naming word).

Very good. Now let's find some more verbs, the words that tell what we can do. (Slides 41-50 Find the verb here, the action word.)

Now let's find the part of speech that tells position, the preposition. (Slides 51-60, Press the button for the preposition, the word that tells place or position.) That was very good. That's all for today.

Slides for Pre-Experimental Training

Session No. 2

	VERBS
1	eat
2	open
3	ask
4	talk
5	think
6	ask
7	talk
8	eat
9	open
10	think

	NOUNS
11	apple
12	baby
13	pencil
14	man
15	cat
16	man
17	pencil
18	baby
19	cat
20	apple

	PREPOSITIONS
21	in
22	across
23	by
24	to
25	at
26	across
27	at
28	in
29	to
30	by

	NOUNS
31	cat
32	man
33	pencil
34	cat
35	pencil
36	apple
37	baby
38	man
39	baby
40	apple

	VERBS
41	talk
42	ask
43	eat
44	talk
45	open
46	think
47	ask
48	eat
49	open
50	think

	PREPOSITIONS
51	across
52	at
53	to
54	by
55	across
56	in
57	to
58	by
59	at
60	in

PRE-EXPERIMENTAL TRAINING: SESSION NO. 3

Today we are going to have more practice at recognizing the parts of speech--the jobs that words do in our sentences. Let's start with the part of speech called the preposition. The preposition is the part of speech that tells place or position. The preposition tells where something is. Look at the first slide. Which word here is the preposition? Press the button for the word you choose. If you get a red light, press the red-light button quickly and try again....By is the preposition. The girl stood by the chair. By tells where, by tells position. Find the preposition.... At is the preposition. You are at school. At tells where, At tells place or position. Find the preposition.... In is the preposition. The toy is in the box. In tells where. In tells position. Find the preposition.... Under is the preposition. The dog is under the table. Under tells where, under tells place or position. Find the preposition.... Before is the preposition. He stood before the house. Before tells where. Before tells place or position. Find the preposition.... Across is the preposition. She walked across the street. Across tells where. Find the preposition.... Behind is the preposition. She hid behind the door. Behind tells place or position. Find the preposition.... Above is the preposition. The plane flies above the city. Above tells place or position. Find the preposition.... Inside is the preposition. She played inside the house. Inside tells where, Inside tells place or position. Find the preposition.... To is the preposition. He went to the store. To tells where. To tells place or position.

Now let's find some verbs. The verb is the part of speech that tells the action. The verb tells what we do. Look at this slide. Press the button for the word which tells something we can do.... Open is the verb. You can open the door. Open tells the action. Find the verb.... Read is the verb. You can read a book. Read tells something you can do. Find the verb.... Ask is the verb. You can ask a question. Ask tells an action you can do. Find the verb.... Talk is the verb. You can talk. Talk is something you can do. Find the verb.... Eat is the verb. You can eat your dinner. Eat is something you can do. Find the verb.... Hit is the verb. You can hit a ball. Hit is an action. Find the verb.... Dig is the verb. You can dig a hole. Dig is an action. Find the verb.... Run is the verb. You can run. Run is an action. Find the verb.... Think is the verb. You can think. Think is an action. Find the verb.... Cry is the verb. Cry is something you can do. Cry is an action.

Now let's find some nouns. The noun is the part of speech that names something or someone. Look at this slide. Press the button for the noun, the naming word.... Cat is the noun. Cat is the name of an animal. Find the noun.... Baby is the noun. Baby is the name of a person. Find the noun.... Apple is the noun. Apple is the name of a fruit. Find the noun.... Man is the noun. Man is the name of a person. Find the noun.... Pencil is the noun. Pencil names something you can write with. Find the noun.... Dog is the noun. Dog is the name of an animal. Find the noun.... Banana is the name of a fruit. Find the noun.... Tree is the noun. Tree is the name of a plant. Find the noun.... Boy is the noun. Boy is the name of a person. Find the noun.

Now let's find some more prepositions. Look at this slide. (Slides 31-40, Find the preposition, the word that tells position. Press the button for the preposition....)

Now let's find the noun, the naming word. (Slides 41-50, Press the button for the noun, the naming word.)

And now let's find the verb, the action word, the word that tells something you can do. (Slides 51-60, Press the button for the verb, the action word, the word that tells something you can do.)

Very good. That's all for today.

Slides for Pre-Experimental Training

Session No. 3

PREPOSITION		NOUN		NOUN	
1	by	21	cat	41	book
2	at	22	baby	42	cat
3	in	23	apple	43	banana
4	under	24	man	44	baby
5	before	25	pencil	45	dog
6	across	26	book	46	boy
7	behind	27	dog	47	man
8	above	28	banana	48	apple
9	inside	29	tree	49	tree
10	to	30	boy	50	pencil

VERB		PREPOSITION		VERB	
11	open	31	in	51	hit
12	read	32	inside	52	talk
13	ask	33	across	53	run
14	talk	34	under	54	open
15	eat	35	behind	55	ask
16	hit	36	by	56	think
17	dig	37	to	57	read
18	run	38	at	58	dig
19	think	39	above	59	cry
20	cry	40	behind	60	eat

PRE-EXPERIMENTAL TRAINING: SESSIONS NO. 4 & 5 [1]

We are trying to learn the parts of speech, the jobs that words do in our sentences. After we learn what these words are, we are going to play some games with them. Only the children who know the parts of speech will be able to play the games. So let's see how well we can do today. Let's try to get all green lights, the first time. First we'll try to find the nouns, the naming words. Look at this slide. Find the noun, the naming word. The noun is dog. Dog is the name of an animal. Dog is a noun.

Find the noun, the naming word. The noun is book. Book is the name of something you can read. Book is a noun.

Find the noun, the naming word. The noun is boy. Boy names a person. Boy is a noun.

Find the noun.... Banana is a noun. Banana names a kind of fruit.

Find the noun.... Tree is a noun. Tree names a kind of plant.

(Slides 6-10, Find the noun, the naming word.)

Now let's find the preposition, the part of speech which tells place or position, where something is. The preposition is behind. The ball is behind the fence. Behind tells where. Behind is a preposition.

Preposition... place or position... The preposition is under. The dog is under the table. Under tells where. Under is a preposition.

Preposition...place or position... The preposition is inside. The girl is inside the house. Inside tells where. Inside is a preposition.

Preposition...place or position... The preposition is before. The boy stood before the window. Before tells where. Before is a preposition.

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[1] Session 5 used the same tape and slides as Session 4.

Preposition...place or position... Above is a preposition. The plane flew above the field. Above tells where. Above is a preposition.

(Slides 16-20, Preposition, place or position.)

Now find the verbs, the action words. Find the verb, something you can do. Run is the verb. You can run.

Find the verb, the action word. Hit is the verb. You can hit a ball.

Find the verb, something you can do. Read is the verb. You can read a book.

Find the verb, the action word. Cry is the verb. You can cry.

Find the verb, something you can do. Dig is the verb. You can dig.

(Slides 26-30, Verb, the action word.)

Now let's find some prepositions, the words which tell place or position. At is the preposition. At tells place or position.

Find the preposition. In is the preposition. In tells place or position.

Preposition. Across is the preposition. Across tells place or position.

Preposition. [illegible] is the preposition. [illegible] tells place or position.

Preposition. By is the preposition. By tells place or position.

(Slides 36-40, Preposition)

All right. Let's find some more verbs.

Find the verb...Think is the verb. You can think.

Find the verb...Talk is the verb. You can talk.

Find the verb.. Open is the verb. You can open a door.

Find the verb.. Eat is the verb. You can eat an apple.

Find the verb.. Ask is the verb. You can ask a question.

(Slides 46-50, Verb.)

Now find some nouns, the naming words:

Find the noun.... Apple is a noun.

Find the noun.... Pencil is a noun.

Find the noun.... Man is a noun.

Find the noun.... Cat is a noun.

Find the noun.... Baby is a noun.

(Slides 56-60, Noun.)

PRETEST 1

The scores on Session No. 5 were used for Pretest 1.

PRETEST 2

Hello, boys and girls. Today we are going to see if you can read the words which say the different parts of speech. Look at the first slide. Find a word here which names a part of speech, one of the jobs that words do in our sentences. Press the button for the word you choose. If you get a red light, press the red-light button quickly and try again. It doesn't matter if you get some red lights to begin with. Keep pressing the buttons until you learn the right word. Then you will get green lights the first time! 1.The part of speech is verb. Verb is the action word. Verb tells something we can do. Find the part of speech here....2.The part of speech is verb. Verb tells something we can do. Verb is the action word. 3. Find the part of speech.... The part of speech is verb, the action word, the word that tells what we can do.

4. Find the part of speech.... The part of speech is preposition. Preposition tells place or position, where something is.

5. Find the part of speech.... The part of speech is preposition. Preposition tells place or position, where something is.

6. Find the part of speech.... The part of speech is preposition. Preposition tells place or position, where something is.

7. Find the part of speech.... The part of speech is noun. Noun is the naming word. Noun names something or somebody.

8. Find the part of speech.... The part of speech is noun. Noun is the naming word. Noun names something or somebody.

9. Find the part of speech.... The part of speech is noun. Noun is the naming word. Noun names something or somebody.

10. Find the part of speech.... The part of speech is verb. Verb tells something we can do. Verb is the action word.

11. Find the part of speech.... The part of speech is verb. Verb is the action word. Verb tells something we can do.

12. Find the part of speech.... The part of speech is noun. Noun is the naming word. Noun names something or somebody.

13. Find the part of speech.... The part of speech is noun. Noun is the naming word. Noun names something or somebody.

14. Find the part of speech.... The part of speech is preposition. Preposition tells place or position.

15. Find the part of speech.... The part of speech is preposition. Preposition tells place or position.

16. Find the part of speech.... The part of speech is noun. Noun is the naming word. Noun names something or somebody.

17. Find the part of speech.... The part of speech is noun. Noun is the naming word. Noun names something or somebody.

18. Find the part of speech.... The part of speech is verb. Verb is the action word. Verb tells something we can do.

19. Find the part of speech.... The part of speech is preposition. Preposition tells place or position.

20. Find the part of speech.... The part of speech is verb. Verb is the action word. Verb tells something we can do.

The procedure used for 1-20 will also be employed in 21-30.

21. Verb; 22. Noun; 23. Preposition; 24. Noun; 25. Preposition; 26. Preposition; 27. Verb; 28. Noun; 29. Preposition; 30. Verb.

PRETEST 3

That was very good. Now let's see if you know the jobs these parts of speech do in our sentences. Look at this slide. Find the part of speech which names something or somebody. Press the button for the word you choose. 1. Noun names something. Noun is the naming word. 2. Which part of speech names something here? Press the button.... Noun is the naming word. No. 7, 13, 15, 17, 21, 22, 25, and 30 are also nouns and are set up the same way as No. 1 and 2.

3. Which part of speech tells something you can do? Press the button.... Verb is the action word. Verb tells something you can do. (Same procedure--No. 4, 8, 10, 11, 16, 20, 24, 26, and 29)

5. Place or position... Preposition tells place or position (Same procedure--No. 6, 9, 12, 14, 18, 19, 23, 27, and 28)

That was very well done. See you all tomorrow!

PRETEST 4

Today we are going to see how quickly you can find the parts of speech I ask for. Let's start with the verb. Remember, the verb tells something you can do. The verb is the action word. Find the verb, the action word, that tells something you can do. 2. Find the verb, the action word.... 3. Find the verb.... (Slides 4-10, Find the verb....)

Very good. Now let's find the nouns, the naming words. Find the noun. 2. Find the noun, the word that names something or somebody....

(Slides 13-20, Find the noun....)

Very good. Now the prepositions; you know the preposition is the word that tells place or position, where something is. 1. Find the preposition, the word that tells place or position.... 2. Find the preposition, where something is.... (Slides 23-30, Find the preposition....)

PRETEST 5

Well, that was very good work. Now we're going to try something a little different. Look at this slide. This slide has the words noun, preposition, and verb. I am going to say a word, and I want you to press the button for the correct part of speech. Listen carefully. Book. Press the button for the correct part of speech. Book is a noun, book names something, so press the button for noun. I want everyone to get a green light. Very good. Now listen. Cat . Press the button for the part of speech for cat. Hit. Press the button for the part of speech.... (Repeat for remaining 30 words. See following list.)

1.	book	n
2.	cat	n
3.	hit	v
4.	in	p
5.	inside	p
6.	talk	v
7.	run	v
8.	banana	n
9.	across	p
10.	baby	n
11.	behind	p
12.	eat	v
13.	pencil	n
14.	to	p
15.	boy	n
16.	man	n
17.	apple	n
18.	dig	v
19.	read	v
20.	by	p
21.	above	p
22.	think	v
23.	ask	v
24.	under	p
25.	cry	v
26.	at	p
27.	dog	n
28.	tree	n
29.	before	p
30.	open	v

EXPERIMENTAL TREATMENT 1. NO HELP GROUP

SESSION NO. 1

Today we are going to play a game. The slides are just a little different from the ones we have used before. Look at the first slide. You see there is one word on top, with no number under it. In the bottom row there are five words, numbered from one to five, just as in our other slides. The game we are going to play is a matching game. First you must read the word on top. Then you must read the five numbered words below it. Choose a bottom word to go with the top word. The bottom word should go with the top word in some way. All the words in this set will be matched in the same way. Look at the number under the word you have chosen. Press the button with the same number. If you get a green light you have chosen the correct word. If you get a red light, press the red light button quickly and try again. 2. Now look at this slide. Find a bottom word that goes with the top word in some way. Press the button with the same number as the word you choose. If you get a red light, press the red light button quickly and try again.... 3. Look at the top word on this slide. Press the button with the same number as the bottom word that matches the top word in some way.... 4. Match the top word here....(Slides 5-15 follow the same procedure.)

That was very good. Now let's see if we can find a way to match the top words in this set of slides. Remember, all the words in the set will be matched in the same way. Go ahead, press a button for the bottom word which you think goes with the top word in some way.... If you get a green light, you have chosen the correct word. Now match this top word in the same way. (All the slides in this set follow the same procedure.)

Very good. Now let's change our way of matching. Look at the top word in this slide. Find a bottom word to go with it in some way. If you get a red light, press the red-light button quickly and try another word. All the slides in this set will be matched in the same way.... 2. Match the top word here. (Slides 3-15 follow the same procedure as Slides 1 and 2.) That was very good.

Very good. Let's try matching this set of words in some way.... (Repeat above for set four.) That's all for today.

EXPERIMENTAL TREATMENT 2. GENERAL CUE GROUP

SESSION NO. 1

Today we are going to play a game. The slides are just a little different from the ones we have used before. Look at the first slide. You see there is one word on top, with no number under it. In the bottom row there are five words, numbered from one to five, just as in our other slides. The game we are going to play is a matching game. First you must read the word on top. Then you must read the five numbered words below it. Choose a bottom word to go with the top word. The bottom word should be the same part of speech as the top word. All the words in this set will be matched in the same way. Look at the number of the word you have chosen. Press the button with the same number. If you get a green light you have chosen the correct word. If you get a red light, press the red-light button quickly and try again. ... 2. Now look at this slide. Find a bottom word that is the same part of speech as the top word. Press the button with the same number as the word you choose. If you get a red light, press the red-light button quickly and try again.... (Slides 3-15 follow the same procedure.)

That was very good. Now let's see if we can find a way to match the top words in this set of slides. Remember, all the words in the set will be matched with the same part of speech. Go ahead, press a button for the bottom word which is the same part of speech as the top word. If you get a green light you have chosen the correct word.... Now match the part of speech of the top word here.... (Slides 3-15 follow the same procedure.)

Very good. Now let's change our way of matching. Look at the top word in this slide. Find a bottom word which is the same part of speech as the top word. If you get a red light, press the red-light button quickly and try another word. All the slides in this set will be matched in the same way. 2. Match the part of speech of the top word here.... (Slides 3-15 follow the same procedure.)

Very good. Let's try matching this set of words. (Repeat for set four.)

EXPERIMENTAL TREATMENT 3. CLASS CUE GROUP

SESSION NO. 1

Today we are going to play a game. The slides are just a little different from the ones we have used before. Look at the first slide. You see there is one word on top, with no number under it. In the bottom row there are five words, numbered from one to five, just as in our other slides. The game we are going to play is a matching game. First you must read the word on top. Then you must read the five numbered words below it. Choose a bottom word to go with the top word. The bottom word should be a verb, like the top word. All the words in this set will be matched in the same way. Look at the number of the word you have chosen. Press the button with the same number. If you get a green light you have chosen the correct word. If you get a red light, press the red light button quickly and try again. ... 2. Now look at this slide. Find a bottom word that is a verb, like the top word. Press the button with the same number as the word you choose. If you get a red light, press the red-light button quickly and try again... (Slides 3-15 follow the same procedure)

That was very good. Now let's see if we can find a way to match the top words in this set of slides. Remember all the words in the set will be matched in the same way. Go ahead, press a button for the bottom word which is a noun like the top word. If you get a green light you have chosen the correct word. Now match the noun here....(Slides 3-15 follow the same procedure.)

Very good. Now let's see if we can change our way of matching. Look at the top word in this slide. Find a bottom word which is a verb, like the top word. If you get a red light, press the red-light button quickly and try another word. All the slides in this set will be matched in the same way. 2. Match the verb here.... (Slides 3-15 follow the same procedure.)

Very good. Let's try matching this set of words. (Repeat the second set.)

EXPERIMENTAL TREATMENT 1. NO HELP GROUP

SESSION NO. 2

Today we are going to play the same game we played last time. Let's see how many green lights you can get. If you get a red light, press the red-light button quickly and try again. But see if you can get the green light the first time. Ready? Let's go. Look at the top word. Choose a bottom word to go with it. The bottom word should go with the top word in some way. All the words in this set will be matched in the same way. Look at the number of the word you have chosen. Press the button with the same number.... (Continue from Item No. 2, same as Session No. 1, No Help Treatment.)

EXPERIMENTAL TREATMENT 2. GENERAL CUE GROUP

SESSION NO. 2

Today we are going to play the same game we played last time. Let's see how many green lights you can get. If you get a red light, press the red-light button quickly and try again. But see if you can get the green light the first time. Ready? Let's go. Look at the top word. Choose a bottom word to go with it. The bottom word should be the same part of speech as the top word. All the words in this set will be matched in the same way. Look at the number of the word you have chosen. Press the button with the same number.... (Continue from Item No. 2, same as Session No. 1, General Cue Treatment.)

EXPERIMENTAL TREATMENT 3. CLASS CUE GROUP

SESSION NO. 2

Today we are going to play the same game we played last time. Let's see how many green lights you can get. If you get a red light, press the red-light button quickly and try again. But see if you can get the green light the first time. Ready? Let's go. Look at the top word. Choose a bottom word to go with it. The bottom word should be a verb, like the top word. All the words in this set will be matched in the same way. Look at the number of the word you have chosen. Press the button with the same number.... (Continue from Item No. 2, same as Session No. 1, Class Cue Treatment.)

Slides for Experimental Training

Sessions 1 and 2 and Posttest A

Problem No. 1 Verbs		Problem No. 2 Nouns		Problem No. 3 Verbs	
think dig	3	book man	5	cry ask	3
cry ask	4	boy book	2	ask think	3
think hit	4	boy cat	1	dig cry	4
ask hit	1	book cat	2	dig think	3
ask cry	2	apple book	3	dig hit	2
cry dig	4	book apple	3	ask dig	2
cry think	2	man boy	2	hit cry	5
hit think	3	apple man	4	think cry	5
hit cry	4	man apple	3	think dig	2
dig ask	1	man cat	2	cry hit	5
dig think	2	boy man	2	cry think	1
dig hit	5	cat boy	1	hit ask	2
hit ask	1	cat apple	5	ask cry	4
ask dig	5	cat man	4	think hit	1
think ask	3	apple boy	5	hit dig	2

Problem No. 4 Nouns			
man cat	5	apple cat	3
cat book	2	apple man	4
cat boy	4	man book	5
man apple	1	boy apple	5
boy book	5	apple book	2
boy cat	2	book cat	3
cat man	4	book apple	1
		book boy	4

POSTTEST A

The scores on the uncued items in Experimental Training Session 2 were used for Posttest A.

NOTE: For all following lists of slides, the first word is the model to be matched; the second word is the word that goes with it. The number after each pair indicates the position on the slide of the second word--the correct answer. The other four words on each slide were distractors from the original population of 80 words.

POSTTESTS B (NOUNS & VERBS) AND D (PREPOSITIONS)

Today we are going to see how well you have learned to play our matching game. Look at the first slide. Read the top word. Then find a bottom word that goes with it. All the words in this set will be matched in the same way. Press the button with the same number as the word you choose. If you get a red light, press the red-light button quickly and try another word. See how many green lights you can get....

2. Look at this slide. Press the button for the bottom word which goes with this top word. If you get a red light, press the red-light button and try another word....

3. Press the button for the bottom word which goes with this top word....

(No. 4-15 follow the same procedure as No. 1-3)

That was very good. Now let's try another way of matching. All the words in this set will be matched in the same way....

2. Match this top word in the same way.... (No. 3-15 follow the same procedure.)

Very good. Let's match this set of slides. Remember, all the words in the set will be matched in the same way.... (Repeat from the second set above

Very good. Now we're going to see if you can match the top words when we mix them all together. Look at the top word very carefully. Then find a bottom word that goes with it. Press the button for the word you choose....

2. Now look at this top word. Find a bottom word to go with it. Press the button for the word you choose. If you get a red light, press the red-light button quickly and try another word.... (No. 3-15 follow the same procedure.)

That was very good. That's all for today.

Slides for Posttests B and D

NOUNS		VERBS		PREPOSITIONS	
tree baby	4	read open	4	by across	5
dog pencil	3	run eat	2	inside behind	1
tree baby	5	open talk	5	above inside	4
baby dog	5	eat run	4	across by	2
banana pencil	4	open read	5	by inside	4
dog baby	2	run open	4	across above	2
pencil baby	1	eat read	5	inside by	1
dog banana	5	open run	4	across behind	2
banana pencil	1	eat talk	2	behind by	3
banana pencil	3	run eat	2	behind across	4
pencil banana	2	talk open	3	inside above	4
baby tree	1	read eat	1	across inside	5
pencil dog	3	talk read	4	above across	5
tree banana	4	read run	5	inside above	3
baby dog	3	talk eat	3	above behind	5

5 ITEMS FOR 3 CONCEPTS (IN RANDOM ORDER)

read talk	3	v	open eat	2	v
across above	1	p	above by	3	p
eat open	1	v	inside across	2	p
run read	2	v	banana tree	1	n
pencil banana	2	n	by inside	1	p
baby tree	4	n	behind inside	3	p
talk run	1	v	dog tree	4	n
tree dog	2	n			

POSTTESTS C (NOUNS & VERBS), E (PREPOSITIONS), AND F (ADJECTIVES), PART I

Today we're going to do the same thing we did yesterday, but the words will be different. We want to find a bottom word to go with the top word in some way. Look at the top word. Then find a bottom word to go with it. All the words in this set will be matched in the same way. Press the button with the same number as the word you choose. If you get a red light, press the red-light button quickly and try another word. See how many green lights you can get on the first try....

2. Look at the top word. Press the button for the bottom word that goes with it in the same way.... (Slides 3-17 follow the same procedure.)

Very good. Now let's match this set of slides. Remember, all the words in the set will be matched in the same way. Press a button for the bottom word which goes with the top word in some way. (Slides 2-17 follow the same procedure.)

Repeat as above for sets 3 and 4.

Slides for Posttests C, E, and F (Part 2)

		C			F		E	
	Nouns		Verbs		Adjectives		Prepositions	
7 practice	chair ball	5	sit play	1	young sweet	4	over from	5
	bed table	2	skate wash	1	bad yellow	3	up around	4
	lamp ball	4	look close	4	sour hard	3	between around	2
	girl lady	2	wash play	5	tall little	2	up from	2
	paper lady	2	jump look	3	sweet fat	2	around down	5
	chair table	3	play close	5	old pretty	1	up around	4
	lady chair	1	look jump	5	young yellow	3	around near	3
10 test items	doll ball	2	skate swim	1	small blue	1	near from	3
	doll lamp	4	swim skate	4	tall blue	5	outside near	2
	chair lady	4	sleep wash	1	short pretty	4	between over	3
	girl house	1	wash close	3	soft hard	3	up over	5
	house lamp	2	drink sit	1	red hard	1	below near	3
	lady lamp	5	jump sit	5	long sweet	4	down around	3
	table lamp	2	swim close	4	pretty yellow	4	outside from	5
	bed doll	2	sit close	2	small little	5	up near	3
	lady ball	2	close drink	1	little yellow	3	outside up	1
	table ball	1	play wash	5	red little	2	near from	5

POSTTESTS C (NOUNS & VERBS), E (PREPOSITIONS), AND F (ADJECTIVES), PART II

Today is the last time we will be playing our games. Let's see how well you can do. First we'll have a few practice slides. All the words in each of these sets will be matched in the same way. Look at the first slide. Press the button for the bottom word which goes with the top word in some way... Now match the top word here in the same way... (Repeat for five slides each for prepositions, nouns, verbs, and adjectives.)

All right. We've had a little practice. This is our last chance to play the matching game. These slides are all mixed up. You must look at the top word on each slide very carefully. Then look at the bottom words. Press a button for the bottom word that goes with the top word. See how many green lights you can get on the first try.... TOTAL OF 40 TEST SLIDES

Slides for Posttests C, E, and F (Part II)

Practice Items				Test Items (Random)							
Preps.	1.	over from	5	1.	to up	1	p	21.	inside outside	4	p
	2.	inside outside	4	2.	small long	1	a	22.	bed lady	2	n
	3.	between over	3	3.	lady lamp	5	n	23.	green sweet	2	a
	4.	above near	1	4.	jump swim	1	v	24.	outside near	5	p
	5.	before below	4	5.	sleep wash	1	v	25.	pretty hard	2	a
Adj.	6.	hard sweet	5	6.	between around	2	p	26.	skate swim	1	v
	7.	big fat	4	7.	sleep play	4	v	27.	fat blue	3	a
	8.	bad yellow	1	8.	good little	1	a	28.	close play	2	v
	9.	blue small	3	9.	between up	3	p	29.	girl house	1	n
	10.	sour long	2	10.	wash close	3	v	30.	table girl	1	n
Nouns	11.	paper lamp	4	11.	lamp ball	4	n	31.	ball paper	1	n
	12.	table doll	3	12.	down around	3	p	32.	swim close	4	v
	13.	chair lady	2	13.	outside over	5	p	33.	to up	1	p
	14.	ball paper	1	14.	yellow fat	3	a	34.	blue sour	5	a
	15.	house doll	1	15.	look jump	5	v	35.	doll lamp	4	n
Verbs	16.	wash play	2	16.	chair ball	2	n	36.	above over	2	p
	17.	jump sit	5	17.	at on	4	p	37.	green long	4	a
	18.	sleep look	5	18.	sweet yellow	3	a	38.	old hard	4	a
	19.	drink skate	1	19.	play wash	5	v	39.	swim look	4	v
	20.	sit close	4	20.	bed table	2	n	40.	house lamp	2	n

AFFECTIVE EVALUATION
(Administered after Last Immediate Posttest)

Very good. Now on this slide we have some pictures with the numbers from one to five. We'd like to know how much you enjoyed playing the games with these machines. If you liked it very much, press button No. 1, the one with the flower. If you didn't like it at all, press No. 5, the one with the star. If you didn't care one way or the other, press No. 3, the button in the middle, the one with the snowman. If you liked it, but just a little, press No. 4. If you liked it quite a lot, press No. 2. Remember, No. 1, the flower, means you liked it a whole lot; No. 2, the arrow, you liked it quite a lot; No. 3, the snowman, means you didn't care one way or the other; No. 4, the eye, means you liked it just a little bit; No. 5, the star, means you didn't like it at all. Think for a minute. Now press a button to tell us how much you liked working these machines.... Thank you all for coming and for being such good scientific helpers.

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